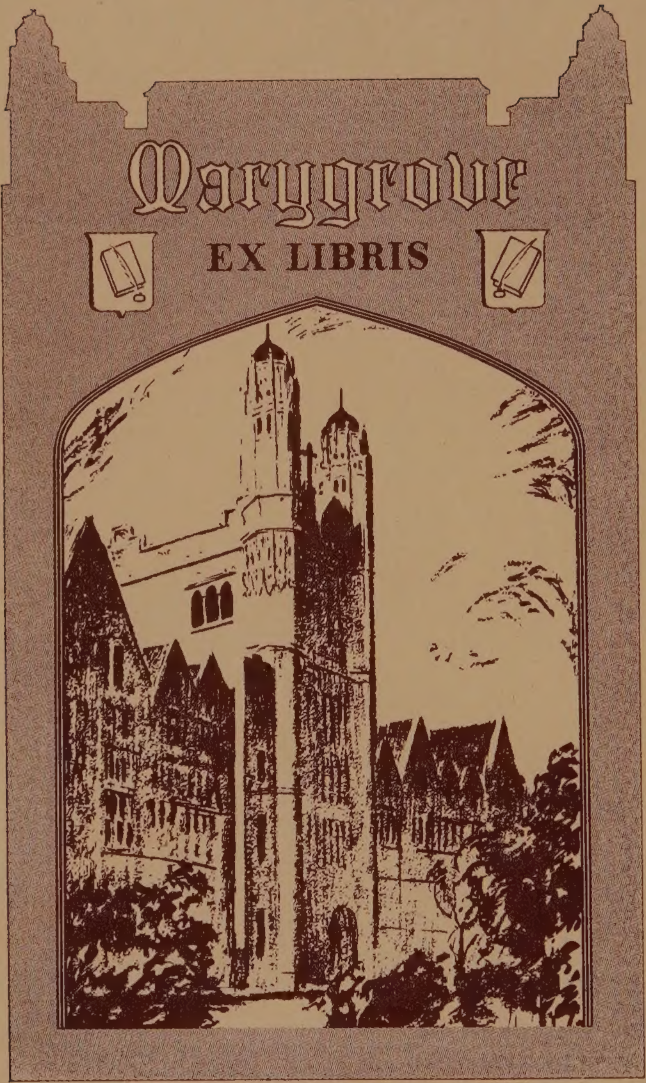
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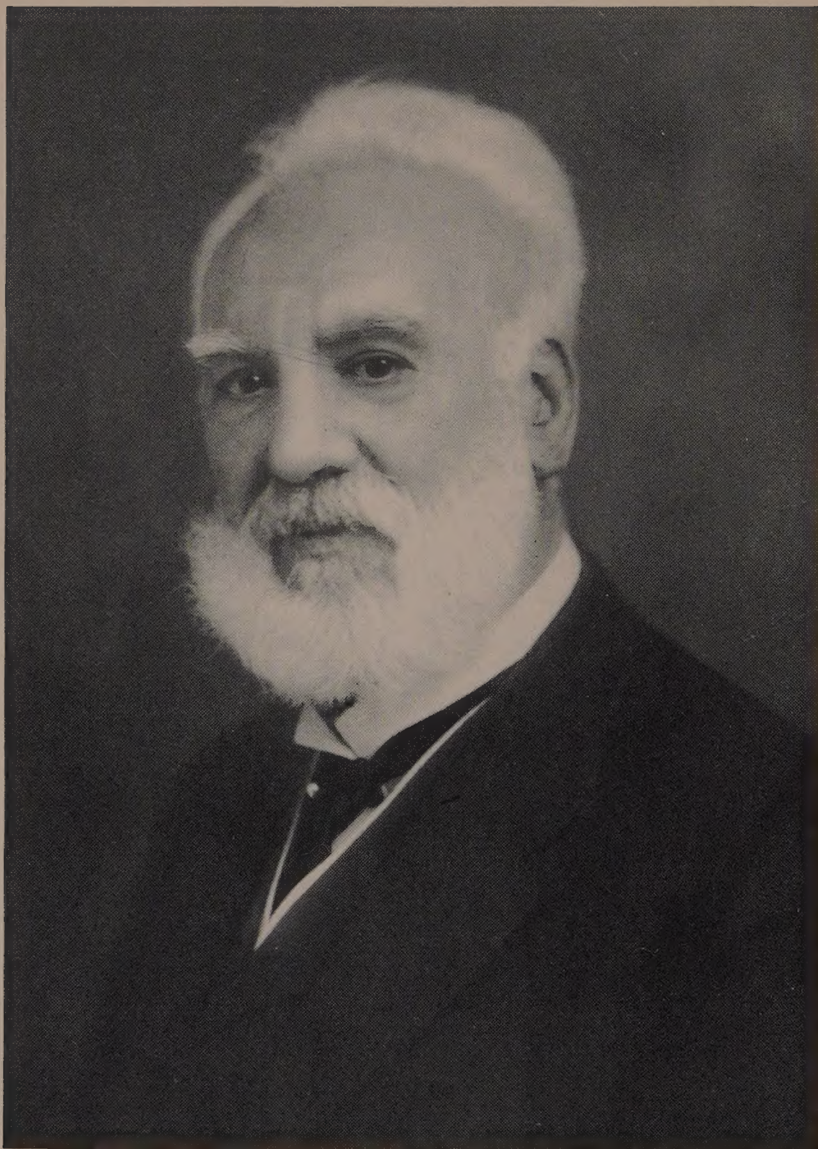
ALEXANDER GRAHAM BELL

The Man who Contracted Space



Alexander Graham Bell

Alexander Graham Bell

The Man who Contracted Space

BY

CATHERINE MACKENZIE

WITH ILLUSTRATIONS

GROSSET & DUNLAP

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TO

E. H. B.

PREFACE

This narrative of Mr. Bell's work makes no pretence to exhaustiveness and none to formal biography. Indeed, I prefer not to call it a biography at all, leaving that title to its more pretentious and more worthy fellows. It is rather the story of a man's life told in terms of the work he did and the way he did it. Much of this work was momentous, some of it trivial, but all of it was animated with the enthusiasm and burning belief that was part of his genius, and, because it was his sole preoccupation, the story of his work is peculiarly the story of his life.

Those who seek for the inner psychology of the man will be able to read it between the lines, to deduce it, certainly, as well as I am able to deduce it. In the days to come, Mr. Bell's family may wish to offer the public a longer and more conclusive study. If they should, this volume leaves ample room for it.

The search for truth was the one really important thing in Bell's life. It is the irony of his story that the malicious charges of fraud, widespread against him during the long and determined effort to wrest the telephone from him, were in complete contradiction to everything essential in his character. Honest, courageous, scornful of double-dealing, the incontrovertible evidence of his prior invention, and his repeated vindication by the courts as 'an honest man with clean hands,' were for years unavailing to quell these charges. They have persisted, ghosts of their once lusty selves, in the whispers still current

that after all Bell was only one of a number of inventors of the speaking telephone.

In his later years Mr. Bell was besieged to write his reminiscences. He invariably replied to these requests that he was still more interested in the future than in the past, and that he was leaving his biography for those who came after him. Nevertheless, he was indefatigable in gathering up biographical material and preserving it in a typewritten record book called the *Beinn Bhreagh Recorder*. It was his intention to have this record available to future students of his life, and as the years passed he laid more and more stress upon its importance. At the time of his death he was arranging further material for its pages.

From the summer of 1914 until his death in 1922 I worked with Mr. Bell, day in and day out, in all of his many activities, much of the time compiling and editing this biographical material under his direction. On this experience, and on the many conversations of these years, I have based this narrative. Mindful of the myths which prevail about Mr. Bell as about all great men, I have made every effort to verify all unsupported or controversial statements. The chapters on the telephone were written only after close study of the voluminous evidence taken in the litigation on the Bell patents, the most extensive patent litigation in history.

I wish to acknowledge with warm gratitude the helpful and friendly assistance of former associates of Mr. Bell, particularly of Mr. Fred DeLand, who has generously read and commented on the manuscript as it progressed. Mr. DeLand was for years

associated with Mr. Bell as Superintendent of the Volta Bureau and was later the compiler of biographical material for Mr. Bell's family. From Mr. F. W. Baldwin, Mr. Bell's last and closest associate, I have had access to the valuable records of the Aerial Experiment Association, and the loan of early volumes of the *Beinn Bhreagh Recorder*, antedating my own copies. Mr. Baldwin has, besides, read and checked my account of the work with which he is most familiar, and without his aid my interpretation of this period must have been very imperfect.

Mr. Thomas A. Watson has kindly read the earlier part of the manuscript covering his own work with Mr. Bell, and I am indebted to him and to his publishers, Messrs. D. Appleton and Company, for permission to quote from Mr. Watson's autobiography, 'Exploring Life.' Mr. George T. Sanders has written me several letters concerning Mr. Bell's association with his family which have supplemented Mr. Bell's own account most helpfully. While the material supplied and the comment received from these associates and friends have contributed greatly to the accuracy of the narrative, I am alone responsible for the interpretation of them, and for the point of view expressed. Mrs. George Kennan; Dr. C. G. Abbot, Secretary of the Smithsonian Institution; Mr. M. O. Hammond of the Toronto *Globe;* and the Registrar of Oxford University, have sent me helpful replies to inquiries on specific points. I desire to acknowledge also the courtesy of Dr. Gilbert Grosvenor, on behalf of Mr. Bell's family, in permitting the facsimile reproduction of Lord Kelvin's letter; and the considerable assistance re-

ceived from Mr. H. M. Lydenberg, Assistant Director of the New York Public Library, and from the Library staff, particularly Mr. N. Morales, of the patent division.

Most of all I wish to acknowledge a very great debt to my husband, Edward Hale Bierstadt, whose editorial judgment I have consulted throughout, and who has further given me specific aid in the unfamiliar business of making a book.

C. M.

New York City
July 15, 1928

ILLUSTRATIONS

ALEXANDER GRAHAM BELL

Alexander Graham Bell

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CHAPTER I

(1)

It was a bleak March day, in Washington, ten years after the Civil War. Grant had some eighteen months to occupy the White House, before embarking on a precarious Wall Street career, and the Capitol was still full of job-seekers. Washington was a city of dreary spaces, of long unfinished avenues that were growing up behind the Capitol. Cheap, dingy stores and hotels walled the muddy expanse of Pennsylvania Avenue. In Congress that year speeches were made concerning the completion of the Washington Monument, which had been started in '48 and still stood 'like a factory chimney broken off at the top.' They went unheeded as usual. Mark Twain surveyed the 'Memorial Chimney,' and immortalized the tired pigs dozing in the holy calm of its protecting shadow. The Nation's Capital, ten years after Appomattox, was still a vast outline with much to fill in.

On that raw afternoon a tall, thin young man sent in his card to the Secretary of the Smithsonian Institution. He had come to Washington from Boston to look after a patent on a device called the harmonic telegraph (or the multiple telegraph), and had brought a letter of introduction to the Smithsonian's

Secretary, Joseph Henry. The old Smithsonian, now obscured by the marble magnificence of its offspring, the National Museum and the Freer Gallery, then stood alone, rearing its castle-like brownstone turrets beyond the half-finished Washington Monument. It was the year 1875.

Professor Henry peered at the card. 'Mr. A. Graham Bell, of Boston,' he read. 'Ask Mr. Bell to come in.'

Professor Henry was one of the great physicists of his day. He was, as Bell wrote home to his parents, 'The Tyndall of America.' Among many important contributions to science, he had made interesting researches in telegraphy, and Bell had duplicated some of these in his own experiments. On this Washington visit he was eager to discuss Henry's results and his own at first hand.

Mr. Bell unwound his muffler and sat down. Professor Henry spoke of the weather, apologized for his cold, blew his nose violently, and waited for his visitor to begin. He noticed the young man's deferential good manners. Henry was an old man, close to the end of a full life. He had been then nearly thirty years Secretary of the Smithsonian — its first Secretary. His name (perpetuated in the 'henry,' the unit of inductance, as Volta's is perpetuated in 'volt') ranked with those of Faraday, Tyndall, and Helmholtz. On a day like this, at his age, with a heavy cold, he should have been at home in bed. Ordinarily he would have been. But chance — or destiny — had brought him to the Smithsonian for this interview.

Bell's dark eyes blazed. As he talked, he gestured

with his fine hands: he ran his fingers through his thick black hair until it stood up on end. He believed everything he said and he talked, then as always, as though it was the one vital thing in the world. Henry began to listen.

Henry listened, in Bell's words, 'with an unmoved countenance, but with evident interest to all, but when I related an experiment that at first sight seems unimportant, I was startled at the sudden interest manifested.'

'I told him,' Bell goes on, 'that on passing an intermittent current of electricity through an empty helix of insulated copper wire, a noise could be heard proceeding from the coil ... He started up, said, "Is that so? Will you allow me, Mr. Bell, to repeat your experiments, and publish them to the world through the Smithsonian Institute, of course giving you the credit of the discoveries?" I said,' Bell continues, '"It would give me extreme pleasure," and added that I had the apparatus in Washington, and could show him the experiments myself at any time.'

The apparatus was at the rooms of Mr. Gardiner Greene Hubbard, where Bell was staying. Henry would come 'at once' and look at it. Had Mr. Bell a carriage? Young Mr. Bell, apparently, had walked to the Smithsonian. Instantly Professor Henry was on his feet — sending for his own carriage, putting on his coat.

Thinking of the weather, of his years, of his cold, Bell was distressed to have Henry risk unnecessary exposure. 'I offered,' he said, 'to save him the trouble of going out on such a raw, damp day, by

bringing the apparatus to the Smithsonian Institute.' Henry was 'very aged — about eighty,' Bell noted. They appointed noon, the next day, for the experiment.

So, on the second day of March, they set up the apparatus at the Smithsonian, the more than half-century between the ages of the two men, the eminence of one and the obscurity of the other merged in their enthusiasm for an idea. Joseph Henry sat at a table 'for a long time, the empty coil of wire against his ear, listening to the sound.'

Bell was then twenty-eight. He was to live to be an old man, and his fame was far to exceed that of the distinguished Secretary of the Smithsonian, but he was never to forget the soaring hope of that moment. 'I felt so much encouraged by his interest,' he wrote a fortnight later to his parents, 'that I determined to ask his advice about the apparatus I have designed for the transmission of the human voice by telegraph.'

For a half-hour on that March afternoon, Joseph Henry listened while Alexander Graham Bell explained the theory of the electric speaking telephone.

(2)

Bell knew next to nothing about electricity. He was a specialist in speech, and his idea had grown out of his expert knowledge of the voice, its physical mechanism, and of sound. 'If Bell had known anything about electricity,' Moses G. Farmer said a year later, 'he would never have invented the telephone.'

In 1874, when he began to work upon it, any good

electrician could have told him that he was attempting the impossible. There had been so-called 'telephones' before Bell's. But they were not electric speaking telephones. The word, from the Greek *tele*, afar off, and *phone*, a sound, obviously means only an instrument to convey sound from a distance. The term was well known and used in that sense for a half-century before Bell. It was probably coined in 1823 by Wheatstone, who exhibited a lyre in one room connected by a long deal rod with a lyre in another room. When the first lyre was played, the vibration carried along the wooden rod caused the second instrument to play in sympathy, and although Wheatstone termed the device a 'telephone,' the wondering populace called it 'the enchanted lyre.'

One of the commonest forms was the acoustic or string telephone, sometimes known as the 'Lovers' Telegraph.' Children improvised these with stretched twine and empty tin cans. Fred DeLand says 'there were sound telephones and steam telephones and musical telephones long before 1876. In Germany the speaking tube was sometimes called the telephone.'

Philipp Reis had sent musical notes, intermittent sounds of various kinds over an electric current, in Germany, a number of years before, and had also called his instrument a 'telephone.'

But *sound* is not *speech*.

It was manifestly impossible, as every one pointed out to Bell, to send the continuous vibration of the human voice, its inflections and overtones, along a make-and-break current. Dots and dashes, yes, but

not voice. Bell agreed that this was impossible. He wasn't going to use a make-and-break current. He was going to make a continuous current of electricity vibrate with the tones of the voice just as the air vibrates with the speaking voice: to substitute electrical waves, so to speak, for the air or ether waves on which our voices are carried in ordinary face-to-face conversation. Then persons miles apart could speak to each other along an electrified wire. He was laughed at.

In an era of the home-made radio, when picking speech out of the upper air is a family commonplace, it is difficult to credit the unbelief in the conception of Bell's telephone only sixty years ago. It was considered so mad an idea that even when he had accomplished it, he was not believed.

Bell, alone of the many experimenters in the field, had hit upon this fundamental principle of electric speech in his ignorance of electricity and in his knowledge of sound. No one, before Bell, had ever reproduced speech by electricity, and no one, since, has ever been able to discover any other means than Bell's to accomplish it. Bell, alone, believed in the validity of the conception 'long before I had a clear idea of the means,' and reduced it to practice through years of opposition, ill-health, poverty — all the familiar discouragements of genius — with a determined faith that assumed nearly epic proportions.

It was far more than the invention of a new apparatus, it was the discovery of a new Art. The Art of telephony was old, but the Art of speech telephony was new.

(3)

At this time Bell was teaching at the School of Oratory of Boston University. There his title was 'Professor of Vocal Physiology.' He also gave lectures on his father's system of Visible Speech to teachers of deaf children. It amounted to a sort of normal training class. And he gave private lessons to a little deaf boy, George Sanders, whose father, Thomas Sanders, a wealthy leather merchant of Haverhill, Massachusetts, was the chief backer of Bell's experiments. A year earlier, Gardiner Greene Hubbard, a Boston lawyer, had become interested in Bell's electrical inventions, and had asked permission to join Sanders in backing them.

In his photographs of the period, Bell looks a rather sad young man, yet his contemporaries speak of his quick stride, his animated gestures, the flashing eyes that were brown, but which all his life were so full of light that they looked black. He was tall and slightly built, with an olive complexion and abundant black hair which he habitually pushed straight up on end. His black side-whiskers and drooping moustache were in the mode of the seventies, and, plus the old-fashioned cut of his coats, they enhanced the air of professorial dignity of which he was then very proud. Bell used to laugh very heartily over some of those old photographs of himself. In those days he tried, he said, to look just as old as his father. 'When I first saw my husband,' his wife said once, 'he was twenty-six and he looked *forty!*'

(4)

When Bell had finished his description on that March afternoon, as he wrote afterward, he asked Henry's advice. 'What would you advise me to do, publish it and let others work it out, or attempt to solve the problem myself?'

'You have the germ of a great invention,' said Joseph Henry. 'Work at it.'

'I said,' Bell recounts, 'that I recognized the fact that there were mechanical difficulties in the way that rendered the plan impracticable at the present time. I added that I felt that I had not the electrical knowledge to overcome the difficulties. His laconic answer was "Get it."' Bell wrote the words in capitals. 'I cannot tell you how much these two words have encouraged me,' he went on, in his letter to his father and mother in Brantford, Canada. 'I live too much in an atmosphere of discouragement for scientific pursuits. . . . Such a chimerical idea as telegraphing *vocal sounds* would indeed to *most minds* seem scarcely feasible enough to spend time working over. I believe, however, that it is feasible, and that I have got the cue to the solution of the problem.'

Bell had conceived this 'chimerical idea' the year before, while spending the summer with his parents in Brantford, but he was occupied with his multiple telegraph at the time, and was being urged to finish it, so that the telephone had to wait.

Improvements in the telegraph were as vital in invention and as profitable to inventors of the seventies as radio improvements are to-day. The American service was notoriously slow, and brought

bewildered complaints from English visitors who often found themselves arriving at a destination in advance of a telegram despatched days before. There was a fortune in a device like Bell's which promised to speed up the service possibly to six or eight times its existing capacity. When he had completed it, and patented it, and sold it to the Western Union Telegraph Company, he was told, he would have plenty of money to spend on air castles like a speaking telephone.

For six months Bell had toiled unwillingly upon an apparatus in which he had lost interest. Speech, electric speech, surged through his brain. But he had no money of his own. He was supporting himself by teaching. His friends, very reasonably, considered the multiple telegraph a bird in the hand. To make matters worse, Bell had fallen desperately in love with Mr. Hubbard's daughter. And more than any one, Mr. Hubbard insisted that he should finish the telegraph. Acquaintances openly tapped their foreheads, and even his friends were becoming a little uneasy about his obsession of sending speech over a wire. Difficulties with the telegraph increased, little difficulties of adjustment that delayed its sale. In the spring of '75, his assistant, Thomas A. Watson, said afterward, 'Bell came as near to being discouraged as I ever knew him to be.'

It was in this crisis that Bell met Joseph Henry. He never forgot the picture of himself, a thin young man in a shabby coat, striding away from the Smithsonian in the rain, the great man's encouragement running like wine along his veins. As long as he lived, Bell never refused to see an inventor, to

look at his drawings or blueprints, or to advise him if he could. Of course the result was that he was deluged with them. And the more mad the idea, the more patient he was. 'I don't want to discourage him,' he would say, 'there may be something in it. *But for Joseph Henry I should never have gone on with the telephone.*'

CHAPTER II

(1)

In a manner of speaking Alexander Graham Bell inherited the telephone. He was the third Bell in direct descent to be an expert in the field of speech.

Early in the nineteenth century, his grandfather, Alexander Bell, was a recognized authority on pure diction, a teacher of speech, and the author of a popular textbook on elocution, familiarly known as 'Elegant Extracts.' On Graham's Bell own evidence, this grandfather was the strongest single influence in shaping his career. And his grandfather's clear, independent thinking, his intellectual honesty, his fearlessness and initiative, and his extraordinary physical and mental vigour were Graham Bell's one pride of ancestry.

This first Alexander Bell began life as a shoemaker in St. Andrews, Scotland, where for generations his Bell ancestors had been shoemakers. His rise to the heights of Shakespearian interpretation from a shoemaker's bench was not extraordinary in the Scotland of John Knox and George Buchanan — both of whom became great from obscure beginnings; yet Alexander Bell was no common man. The daguerreotype portraits of him show the striking good looks, the mop of snow-white hair, the big Bell nose, the resolute jaw, and the expressive hands which his grandson inherited.

In 1814, when he was twenty-four, Alexander Bell

married Miss Elizabeth Colvill, daughter of a Fifeshire family. Miss Colvill was thirty-one.

The Bell *flair* for the theatre first appears in the family annals, three years after this marriage, when Alexander Bell was noted in a parish record as a comedian. Soon after 1817 he took his wife and child from St. Andrews to the larger opportunities of Edinburgh, where an older brother, James Bell, was comfortably established as a brewer.

When he went to live in Edinburgh, Alexander Bell was between twenty-seven and twenty-eight, about the age at which his grandson invented the telephone. Not long before his advent, the Black Watch and the Seaforth Highlanders had swung up the Royal Mile, from Holyrood to the Castle, back from Waterloo. The first issue of that now venerable institution, *The Scotsman*, had just appeared. Fourteen times a week the London stage-coaches left the Black Bull, thundering down by Newcastle and York at twelve miles an hour over the fine new roads surfaced by the ingenious process of Mr. MacAdam. They were soon supplemented by steam packets from Leith. Presently, the uncertain gloom of Princes Street was dispelled by the glare of fifty-three gas lanterns. Edinburgh moved with the times, and so did Alexander Bell.

The parish records and the entries of his children's births are milestones in this Edinburgh progress. He is first noted as a grocer, then as the owner of a tavern, and then as an actor on the stage of the Theatre Royal.

Undoubtedly Alexander Bell had marked histrionic gifts. The inheritance was unmistakable in

both his son and his grandson. But the reputation and fortune toward which his ambition spurred him were rare in the theatre of his day, and neither was to be gained in minor rôles on the Edinburgh stage of 1817. Only for such renown as Mr. John Kemble's were the civic dinners and the presentation gold snuffboxes of the period.

Perhaps this influenced his next move. Perhaps, too, the Theatre Royal, its eighteenth-century odium still upon it, was no place for the son-in-law of the respectable Colvills. Whatever his motives, Alexander Bell abandoned the stage. He became a 'corrector of defective utterance' and a public reader of Shakespeare's plays. Presently he returned to his native St. Andrews to teach English diction in one of the rooms, if not under the ægis, of its ancient University.

Later, Alexander Bell opened a successful school for boys at Dundee, that busy town on the Firth of Tay now widely known for the excellence of its marmalade. Their vicissitudes over, Elizabeth Colvill had a servant, drove out in a carriage, and had her portrait painted with her three children. It was an atrocious portrait, but it shows her in a head-dress modishly built up on a foundation of wire, and the infants wearing the conventional *décolletage* of affluence. Much later, Alexander Bell retired to London, where he had a house on Harrington Square, and where, long afterward, he taught his grandson, Graham Bell, to recite Shakespeare in his turn.

(2)

Alexander Bell's second son, Graham Bell's father, was born during the transitional Edinburgh period of the family fortunes in 1819. He was baptized Alexander for his father and Melville in memory of a favourite cousin, young Captain Melville Richard, master of the *Jane of Glasgow*, lately deceased in a Jamaican port.

Alexander Melville Bell inherited his father's capable mind and energetic ambition, and inherited too, the Bell *flair* for the theatre. He was destined, further, greatly to advance and consolidate the Bell fame in the field of speech.

Melville Bell was eighteen when, in 1837, the guns from the Castle Rock boomed out the royal salute to Victoria's long reign. A year or two later, to recuperate from a severe illness, he went out to Newfoundland to stay with a friend of the family.

Melville Bell always spoke of having begun his teaching career in Newfoundland. He stayed for four years and completely regained his health. He supported himself as a clerk in a shipping house, and in his leisure organized a class in the study of Shakespeare. He corrected faults of speech, following his father's methods, and won further local renown by installing a speaking tube in a shop — an innovation for St. John's in the early forties. And he directed amateur theatricals — with Cleopatra in a new London gown, a wreath of rosebuds in her hair, gold bracelets, and white kid gloves; and Antony, splendid in the uniform of a garrison officer, with gilt buttons and varnished boots.

Melville Bell always made hosts of friends, and on

leaving St. John's, his companions, sincerely desolated at his going, gave him a public dinner and drank copiously to his health and his future. This propitious American episode not only initiated Melville Bell's own career, but was to influence profoundly the career of his son.

In 1842, just after his twenty-third birthday, Melville Bell returned to London and became his father's professional assistant. The following year he determined to embark on a teaching career in America, and went to pay a farewell visit to Scottish friends. In Edinburgh, in the summer of 1843, he met and fell in love with Eliza Grace Symonds. He abandoned his American plans, stayed in Edinburgh, and they were married the next year.

(3)

Miss Symonds was the daughter of a surgeon in the Royal Navy. She was a teacher of drawing and a painter of miniatures in Edinburgh. She was thirty-five. Melville Bell was ten years younger. History was repeated.

About the time of their marriage, Melville Bell sat to her for a water-color sketch, in which he appears as an extraordinarily handsome youth with masses of black hair, fine eyes, a lively, winning expression, and completely magnificent attire. The spreading lapels and tight sleeves of his full-skirted coat, the wide satin bow tie, and the suspicion of whisker behind the starched points of his collar are all in the very perfection of the mode. In her own portraits of herself, Miss Symonds was steadily unflattering, but if, by the evidence of her own candid

brush, she was not beautiful, she was plainly a lady of great sensitiveness, sweetness, and good sense. She sat at her easel in the dreary Dundas Street lodgings, an apron protecting the flounces of her be-ribboned green gown, a scarf on her smooth brown hair, and before the portrait was done one feels sure that the captivated sitter was down on one knee, the lady's slender hand in his, declaring his passion with all the eloquence of his art and the ardour of twenty-five years.

The Melville Bells took a flat in the neighbourhood of Charlotte Square, 16, South Charlotte Street, in one of those dark Edinburgh houses of the period with a 'common stair.' In the next six years there were three babies, all of them boys.

The second, born on his grandfather's birthday, March 3, 1847, was baptized Alexander. This was Alexander Graham Bell. To his family he was 'Aleck' as long as he lived.

That year Jenny Lind came to sing in Edinburgh at the Music Hall. It was an event not outshone the next year by the appearance there of 'M. Chopin, the distinguished composer and musician.' The Bell family, with all of Edinburgh, illuminated their windows when Queen Victoria set the fashion that year for Highland touring. It was the year when public apprehension was divided between the polar expedition of Sir John Franklin, gone in the *Erebus* and the *Terror* to its Arctic fate; and the explorations of Mr. David Livingstone, then settling in the heart of Africa; and when the wonderful electric telegraph, lately introduced into Edinburgh, was the newest marvel in Charlotte Square.

Across the Atlantic, in December, Mr. Joseph

Henry presented the first annual report of the newly established Smithsonian Institution.

(4)

In the mid-forties, in Edinburgh, Melville Bell was advertising in the city directory as 'Professor of Elocution and the Art of Speech.' And, like his father, he gave public readings from the works of William Shakespeare. Dramatic readings were then, and long continued to be, a popular relaxation for that part of the British public which discountenanced the theatre. Young persons who were never permitted to attend the play might with propriety be taken to a public reading of 'Twelfth Night,' with the agile and versatile young Mr. Bell in every rôle. Later, however, Melville Bell was to resign his church membership when he received the scandalized protest of its elders on his public readings from the flippant works of Mr. Charles Dickens.

Soon he announced his famous system of alphabetics known as 'Visible Speech.' George Bernard Shaw was to learn of the system long afterward and to build around it his play 'Pygmalion.' In Shaw's comedy the atrocious diction of the Cockney, Eliza Doolittle, is so transformed by the means of Bell's Visible Speech that she passes for a duchess at the king's garden party.

In Visible Speech, Melville Bell reduced to a series of printed symbols the anatomical positions which the speaking organs take in uttering sounds. These symbols were so drawn as to indicate the shapes taken by the lips, the positions of the tongue, and so on, and once a sound was written in its

proper symbols, the initiate had only to reproduce the physical position with his own organs of speech in order to reproduce the sound. There was, for instance, a symbol indicating 'closed lips, voice passed through the nose.' When the lips are closed and a nasal sound made, the result is the sound of *m*, whether the language is English or Choctaw.

There were only ten basic symbols, and these, in various combinations, covered the whole range of vocal sound in any tongue.

The language-teaching possibilities of this system were obviously great, and it was hailed as 'the foundation of that dream of the philologists, a universal language.' The spoken language of the Chinese was to be first written in Visible Speech. It brought Melville Bell deserved fame during his lifetime, and was perhaps the most important link in that chain of inheritance which brought about the invention of the speaking telephone.

(5)

From 16, South Charlotte Street, where the third Alexander Bell was born, the family moved to 13, Hope Street, and — as pupils increased in number and reading engagements multiplied — finally to 13, South Charlotte Street, where Bell lived as a boy. This was the only house of the three that he remembered.

The three boys, Melville James, Alexander, and Edward Charles, were taught at home by their mother. When Aleck was eleven, the flat on Charlotte Street was supplemented by a cottage at Trinity, a suburban parish of Edinburgh, then in the open country but now within the city limits. This,

Milton Cottage, provided an out-of-door playground and was the scene of very happy years.

A friend of Melville Bell, a Mr. Alexander Graham — home from his Cuban plantations — visited the Bell family about this time, and aroused Aleck's childish admiration. From him, on his eleventh birthday, Aleck adopted the name 'Graham' — chiefly because he liked it. He was accustomed to explain, in later life, that he had assumed it because he found it inconvenient to be the third of the name in the same profession, and 'to distinguish myself from my father, and grandfather, both Alexanders.' It seems unlikely that, at eleven, its professional inconvenience weighed very heavily with him, but he undoubtedly wanted to have a name of his own, and the circumstance is early evidence of the youngster's characteristic independence. Out of consideration for his grandfather, of whom he was fond and whose namesake he was, he made little use of the 'Graham' until after the death of Alexander Bell. In later life he was widely known simply as Graham Bell.

From his musical mother Aleck inherited the acute ear which was one day to pick up the faint 'ping' of a wire accidentally plucked in a Boston attic, and to recognize in it the electric transmission of speech. He showed musical talent when he was a very small boy, and began to have regular piano lessons 'at a very early age' from Signor Auguste Benoit Bertini. To have one's small son taught by Bertini in Edinburgh then must have been tantamount to having Ernest Hutcheson drop in now on Tuesdays and Fridays to give one's child a lesson in solfeggio. Bell never got over his childish awe of

Signor Auguste Benoit Bertini — he liked to give him his full name. These were not simply conventional 'music lessons,' however. The boy enjoyed music, and it was his solace all his life. He was such a promising pupil that Bertini wanted him to become his successor. After Bertini's death, Aleck's mother continued the lessons. She had been hard of hearing for some years, but she still played the piano. For a long time Bell's consuming ambition was to become a professional musician, to wear a flowing tie and a wide hat, to sway audiences to his tumultuous music, to be a little melancholy, and very, very romantic — like Signor Auguste Benoit Bertini.

Like many other emotional, imaginative children, Aleck wrote verses to Nature — lines on a Blackbird, 'To a Flower,' on the Aurora Borealis, neither better nor worse than the poetic flights of other children — and these his mother fondly preserved. At thirteen he inscribed these lines to his grandfather, Alexander Bell:

MANY HAPPY RETURNS OF THE DAY TO GRANDPAPA BELL

I am thirteen years old I find,
  Your birthday and mine are the same.
I wish to inherit your mind,
  As well as your much honoured name.
To-day you are threescore and ten;
  Your once raven locks are now white,
You have reached the allotment of men,
  With a heart that's both joyful and light.
Live on still in comfort and peace,
  Your cares loving friends will allay,
May you have of this life a long lease;
  Many happy returns of the day.

At fourteen, Aleck composed a very creditable

acrostic sonnet, considering the limitations of this form, in honour of his father's birthday. He adorned the top of the page with a bell, in a pen-and-ink outline — unwittingly the original of that blue symbol which now guides our search for a public telephone.

(6)

In the Edinburgh of Bell's childhood, as now, the tall houses, wynds and closes of the Old Town recalled a time when life was unsafe outside the High Street. But Princes Street and the New Town had begun to spread out in his grandfather's day, and were established in his childhood much as they are now. The windows of the pastry-cooks on Princes Street were as temptingly full of the little mutton pies for which he and his brothers saved their hapence. These leaden dainties, esteemed by young males far above the packages of 'Edinburgh Rock' sugar-candy, and shortbread in tartan wrappers, drew Aleck's fascinated and insatiable gaze as he loitered home from school.

He was to remember the movement and colour that the Crimean War brought to garrisoned Edinburgh, his mother's tearful admiration of the heroic Miss Nightingale, and — dimly — the distant shouting, 'Sebastopol is down.' He remembered rather better the later illuminations, the guns, the pipes, and the cheering when Auld Reekie welcomed home the Highlanders who had relieved Lucknow.

(7)

When he was ten, Aleck was entered at a private school in Edinburgh, where he remained a year.

For the next two years he attended Dr. Donaldson's class at the Royal High School. He seems to have been undistinguished in his classes, and indeed, by his own acccount, to have been rather indolent. He could not have been conspicuously idle, however, since he was duly graduated at fourteen. Bell took occasional lectures afterward, in Edinburgh and in London, but this was the sum of his formal education.

His school days do not appear to have differed in any important particular from those of any other healthy little boy in the late fifties, who shirked his Latin, and whose pleasantest recollections after sixty years were to be of long afternoons, scrambling up Arthur's Seat, and wandering on the Corstorphine Hill, his Skye terrier at his heels, and of unattainable mutton pies in the window of a Princes Street shop. When Queen Victoria and the Prince Consort came in state to Holyrood, and the pupils of the Royal High School had a holiday, he made loyal and appreciative noises with the other boys, and went off to play with young Herdman at the Herdman Mills.

(8)

Aleck's life at home was exceptional if his school days were not. Speech was the family preoccupation and both of his parents were professional teachers. 'From my earliest childhood,' Bell said, years later, 'my attention was specially directed to the subject of acoustics, and specially to the study of speech, and I was urged by my father to study everything bearing upon what was to be my professional work.'

The father and mother encouraged the three boys in their various enterprises and hobbies, and interfered as little as need be. The three collected minerals, wild flowers, beetles, and birds' eggs, and then — as boys have always done — tired of these and went on to something else. Aleck went through a period of intense scientific inquiry in which he dissected field mice and collected the skulls of other small animals for his 'museum.' He liked to pick flowers, and used to say that he had been passionately fond of botany until some well-meaning adult 'tried to help me and showed me how I should hunt up each plant in a book and classify it by a long Latin name. That spoiled the whole thing for me.' It would. He was always an individualist. He didn't like to play games.

During the Milton Cottage years Melville Bell, characteristically alert to everything new, was one of the pioneers in amateur photography. Indefatigably, he and the three boys photographed one another, singly, in groups and with Aleck's dog, in the garden of the Trinity Cottage. In surviving glass plates they are shown in thoughtful poses against the garden lattice or a stone urn, with the unnatural melancholy of expression common to the art in its inception. Their mother has given a more lively, if slightly idealized picture of the children in an earlier water-colour, in which Aleck, in a striped dress and mid-Victorian pantaloons, is alertly posed with a bow and arrow. His curly hair was brushed up on end even then.

The conventional austerities of the Scottish Sabbath did not confine the freedom of Milton Cottage

— as witness the episode of Mr. Charles Dickens; but the boys were obliged to memorize the text at church services, and to repeat the substance of the sermon afterward to their mother, who, as has been said, was partially deaf. Mrs. Bell was deeply religious and, for a time, Aleck suffered agonies of conscience over childish sins.

(9)

Throughout their childhood, Melville Bell systematically encouraged his sons' interest in speech. He was punctilious about their own diction and pronunciation, and, because his father was contemptuous of language with an 'accent,' Aleck grew up to speak a particularly pure, unaccented English. He could not be identified either as an Englishman or as a Scotsman by his speech.

Once, on a London visit, Melville Bell had heard a performance of 'Euphonia,' Professor Faber's 'speaking machine,' making its mechanical noises at the Egyptian Hall. He offered the two older boys a prize if they could make a speaking automaton for themselves. 'I don't suppose he thought we could produce anything of value in itself,' Graham Bell used to say, 'but he knew we could not experiment and manufacture anything which even tried to speak, without learning something of the voice, and the throat and the mouth — all that wonderful mechanism of sound production in which he was so interested.'

Neither boy had ever seen an automaton, so they decided to copy the structure of the human organs of speech. It is more than likely that the decision

was their father's, suggested so unobtrusively that they thought it their own. 'My brother and I went to work,' Bell explained; 'he was to make the lungs and the vocal cords, I was to make the mouth and the tongue. He made a bellows for the lungs, and a very good vocal apparatus out of rubber. I devised a skull and moulded a tongue with rubber, stuffed with cotton wool, and supplied the soft parts of the throat from the same material. Then I arranged the joints, so that the jaw and the tongue could move. It was a great day for us when we fitted the two parts of the device together. Did it speak? Well, it squeaked and squawked a good deal, but it made a very passable imitation of 'Ma-ma, Ma-ma'!

The great thing was that it worked, Melville energetically plying the bellows; Aleck opening and shutting the lips. And if its 'Ma-ma' which transported the youngsters was actually somewhat less human than it seemed to their prejudiced ears, its construction had taught them the mechanism of human speech. Melville Bell was satisfied.

In the late summer afternoons the family at Trinity would sit out in the garden, Melville Bell analyzing the raucous speech of the boy's parrot; Mrs. Bell with a full mending-basket instead of a sketchbook now; Aleck holding his Skye terrier between his knees, opening and shutting its jaws, trying to make it growl 'How-do-you-do.'

(10)

After he left the Royal High School, Aleck was invited to London to spend a year with his grandfather. Alexander Bell was seventy-one. He was

still giving lessons in speech, but his second wife had died the year before, and he was a lonely old man, in an empty house on Harrington Square.

London was full of delights for a visiting schoolboy in the early sixties. The wonders of the Polytechnic with its tank and diving bell vied with the attractions of a new hippopotamus at the Zoo, Madam Tussaud's waxworks, and the appearances of Tom Thumb; but none of these remained as a lasting impression with the fourteen-year-old Bell. The one thing he never forgot was the tight and terrible discomfort of his new clothes. He had arrived in London wearing 'clothes that my father and mother thought good enough for a schoolboy.' But the fastidious Alexander Bell had taken one horrified look at him, and had sent for his tailor. Clumsy tweeds might be all very well for suburban Edinburgh, but no namesake of his was to be seen in them in Harrington Square.

The house at Number 18 faced the tall iron railings of Harrington Gardens, named — one likes to think — for the amiable Earl who wore a sage-green beaver hat when he walked among his trees so that he might not frighten the birds. As in other small London parks, only residents of the square had keys to the gate. As soon as Aleck's new outfit was ready, he was sent daily for a walk in the enclosure, 'to be shown off.' And, miserable in tight, new, unaccustomed trousers, an Eton jacket and a top hat, the youngster was very homesick for Edinburgh. He drove around the square, sixty years later, and recalled the scene. 'And mind you,' he repeated, 'I had to carry a *cane!*' That had impressed him as an

overwhelming affectation. But, long as he remembered and laughed over the far-off misery, it was only incidental in the deep and abiding influence of that London visit. A visit that was, in his own phrase, 'the turning-point in my whole life.'

He went up to London a rather careless, indolent little boy, and 'My grandfather,' he used to say, 'made me ashamed of my ignorance.'

Apparently Alexander Bell found little enough to approve and gaps that appalled him in his grandson's education. Here was his namesake, at fourteen, knowing no Latin to speak of, and not a line of Greek. He knew nothing of the classics. It could not have reassured the grandfather to learn that the youngster's dearest ambition was to play the piano in public for his living. He would have to get that idea out of his head. For Alexander Bell the elder there may have been disquieting memories here of an old ambition for comedian rôles on the Edinburgh stage.

The grandfather took the lad in hand. He outlined his reading. Aleck began to take himself very seriously. He was admitted to some of his grandfather's classes so that he might become familiar with speech-teaching methods. Before the year was out he had read through his grandfather's library on acoustics. He felt that he could never catch up with his wasted years. Life was real and very earnest, and playing the piano was no very solid accomplishment and far from an ultimate goal at Number 18, Harrington Square. The image of Signor Bertini was not as distinct as it had once been. The third Bell began to plan for his career in speech.

In London, that year, Edward, Prince of Wales, as Baron Renfrew, came back from his visit to the United States and Canada. The London newspapers commented the while upon the possibility of an American bride for the succession. Every one breathed more freely when the Queen and the Prince Consort returned from a visit to Ireland, which 'had passed off without untoward incident.' The fashionable undertaker, Mr. Banting, proclaimed his theory and practice of weight-reducing to an overfed populace, and shared the headlines in the day's news with the sermons of Mr. Spurgeon, the notorious murder in Northumberland Street, and — distantly — the rumours of Civil War in America. And in the gloomy drawing-room of 18, Harrington Square, its moreen curtains screening out the yellow London fog, a serious, pale youngster ran an agitated hand through his hair, stuck on the lines he was reciting,

'*To be, or not to be, that is the question . . .*'

floundered, and went on, to his grandfather's prompting.

CHAPTER III

(1)

The candour of his attitude toward defects in speech had brought Melville Bell early recognition. In the forties he was lecturing at the University of Edinburgh and later at the New College.

It was the era of assorted twaddle in the treatment of stammering or other impediments of speech. The majority of teachers 'sought by every means either to throw an air of mystery or exclusive secrecy around their methods.' Treatment of speech defects varied from magical charms to a fork on the tongue, tubes between the teeth and pebbles held in the mouth. Alexander Bell had thrown the first bombshell into this conjuring fraternity years before, and now Melville Bell strode delighted into the fray with the challenge that 'the habit of stammering can only be counteracted by the cultivation of a habit of correct speaking founded on the application of natural principles. Respecting these there is no mystery except what arises from the little attention that has been paid to the science of speech.'

Aleck made his first public appearance in a test of his father's system of Visible Speech. One of these tests, later repeated publicly in Glasgow, is described by the Reverend David Macrea, a contemporary and a friend of Melville Bell.

'We had a few friends with us that afternoon,' Macrea wrote, 'and when Bell's sons had been sent away to another part of the house, out of earshot,

we gave Bell the most peculiar and difficult sounds we could think of, including words from the French and the Gaelic, following these with inarticulate sounds as of kissing and chuckling. All these Bell wrote down in his Visible Speech alphabet and his sons were then called in.

'I well remember our keen interest and astonishment as the lads — not yet thoroughly versed in the new alphabet — stood side by side looking earnestly at the paper their father had put in their hands, and slowly reproducing sound after sound just as we had uttered them. Some of these sounds were incapable of phonetic representation with our alphabet.

'One friend in the company had given as his contribution a long yawning sound, uttered as he stretched his arms and slowly twisted his body like one in the last stage of weariness. Of course Visible Speech could only represent the sound and not the physical movement and I well remember the shouts of laughter that followed when the lads, after studying earnestly the symbols before them, reproduced the sound faithfully, but like the ghost of its former self in its detachment from the stretching and body twisting with which it had originally been combined.'

In 1860, Melville Bell and his brother David brought out 'Bell's Standard Elocutionist.' It appeared about the time that Charles Darwin was publishing the 'Origin of Species,' and if Bell's book was relatively obscure, it was nevertheless to have an influence on contemporary manners nearly as profound as that which Darwin's great work had on contemporary thought. The 'Standard Elocutionist'

went into one hundred and sixty-eight editions before 1893. It has gone into many more editions since, and is selling steadily now. It is still used as a textbook in Great Britain. It was the prop of the amateur elocutionist on two continents for fifty years. And if it was more or less responsible for a depressing number of public speakers, along with the recitations of the perennial young lady in Swiss muslin and ribbons, it, at least, did more than any other agent to make public speaking articulate. 'Bell's Standard Elocutionist' has never had a rival and, indeed, covered the whole field of elocution with such completeness that there was nothing left for any one else to say. It remains the last word on the subject.

(2)

Aleck came back to Edinburgh from his year on Harrington Square to find that he 'couldn't bear to be treated as a schoolboy any longer.' He had had an allowance of pocket money during his London year, which his father did not continue. Devoted husband and father as he was, Melville Bell kept the family purse strings in his own hands as long as he lived. The smallest household expense was accounted for, and separately paid — by him. He could cheerfully sacrifice the ambitions of his whole lifetime for his son's good — but he could see no necessity for an allowance of pocket money for a boy of fifteen. Aleck climbed the Corstorphine Hill, and, looking off toward Leith from 'Rest and be Thankful,' dwelt on the possibility of running away to sea. It is very unlikely that he did more

than ponder the exploit vaguely, as other boys have done when their pocket money has been stopped. But the heady air of his London independence was still in his nostrils and he was irked by a parental supervision which he thought he had outgrown. Melville Bell was securely established in Edinburgh, and, after an apprentice period, his sons might look forward to a share in his professional work. But Aleck was seeking his own horizon. Under his grandfather's influence he had determined upon teaching as his life work, and he decided that he might as well begin. Teaching, teaching anything — teaching for its own sake — amounted to a passion with Bell as long as he lived. He taught as some men compose music, or paint on canvases, or follow the sea, and he was to find his fullest expression in the teaching rôle.

He fired his brother Melville with his own, still secret, ambition, and they watched the 'wanted' column of *The Scotsman* for weeks. One day a Mr. Skinner advertised for two pupil teachers for his school in Elgin, Morayshire. One vacancy was for elocution, the other for music. Melville, who had helped with his father's classes, was best equipped to teach elocution. Aleck could play the piano, and anything he could do he could teach. Perhaps the old tenacious image of Signor Bertini was wearing through and blurring the nearer outline of Aleck's London year.

They drafted their application to Mr. Skinner, omitted their ages (Aleck was now close to sixteen, Melville two years older), and, naïvely assuming that it would never be used, gave as reference the

name of the well-known Professor Alexander Melville Bell of Edinburgh!

Mr. Skinner's enquiry presently reached Professor Bell, hastened, no doubt, by the coincidence of names, and, after some dignified adult interchanges, the father, sensible man that he was, let Aleck go to Elgin. It was arranged that the youngster should tutor in both music and elocution! The other lad became his father's assistant in Edinburgh.

For a year Aleck remained as a pupil teacher at the Elgin school, and then returned to take lectures in Greek and Latin at the University of Edinburgh. He went back to Elgin when he was seventeen, as a teacher of elocution and music — a resident master — in the Weston House Academy.

It was from this last experience that most of Bell's Elgin reminiscences dated. One feels that the parental correspondence with Mr. Skinner had somehow tamed the heyday in his blood in his first teaching year. But during the Weston House Academy period, Bell sat to an Elgin photographer, holding a top-hat with an air of jaunty confidence absent in all other early portraits. He played piano accompaniments of the fashionable part-songs for young ladies in Garibaldi blouses. He was grown up.

Three miles from Elgin was the ruin of Pluscardyn Abbey, ivy-grown, romantic, deserted. It was Bell's favourite haunt. The old walls, open to the sky, enclosed a soft grass plot where a cloister had been. The roof had gone, probably, with the lead roofs of other Scottish abbeys and cathedrals to swell the national revenue under the debatable economies of the Regent Morton. The tower threw a little shade,

and in the stillness there was the harmony of some amiable brotherhood, long scattered. It was a pleasant place to be after a week of teaching music to little boys whose unwilling hands fingered the keys, but whose hearts were on the playing fields. On fine Sundays Bell's long stride took him to its seclusion, where he lay through unbroken afternoons, dreaming the dreams of seventeen.

CHAPTER IV

(1)

WHILE at Weston House, in Elgin, Bell made his first serious, independent researches in the study of sound.

There he experimented with the resonance of the mouth cavities, holding a pencil in various positions against the cheek and throat, and tapping it while taking the vowel positions, making 'what I then deemed to be an original discovery, that vowel quality was produced by the resonance tones of the mouth cavities mingling faintly with the tone of the voice.' This was in 1865.

Meantime, Alexander Bell had died at his London house. Melville Bell, leaving his pupils and other professional work in the hands of his oldest son, Melville James, removed in that year to London.

There Melville Bell became the intimate of the famous philologist, Alexander John Ellis. Ellis was later the translator of Helmholtz, the great German physicist, best known for his 'Analysis of the Spectrum,' but equally famous then for his work on sound. Ellis had done more than any other scholar to advance the scientific study of phonetics, of early English pronunciation and of existing English dialects. He was president of the Philological Society of London. To the endorsement and support of Ellis, Melville Bell owed much of his later London success, support that was the more generous since Bell's system of Visible Speech was obviously to

supersede Ellis' own system on which, he said, 'I have laboured for many years and expended much money.'

Through Ellis, Melville Bell met and exchanged visits with the famous linguist, Prince Lucien Bonaparte, then compiling his monumental treatise on the Basque verb with very much the same activity and dash that his illustrious uncle had exhibited in crossing the Alps. Prince Lucien was the son of Lucien Bonaparte, the most gifted of Napoleon's four brothers. He had much of his father's brilliance and energy, and to his inherited capacity for languages he had added the sound scholarship that made him famous as a linguist. At fifty-two, when Melville Bell met him, Prince Lucien was not only plunged into the intricacies of the Basque syntax, but was contributing to a score of works on comparative philology. He was further occupied with an idiomatic version of the Song of Solomon, produced finally in twenty-two English dialects and four of the Lowland Scottish. Bell's system of Visible Speech was manifestly an inspired response to His Highness's passion for dialect sounds.

London was a stimulating place for any enquiring mind in the sixties. Although certain sections of the clergy still debated the exact date of the first day of creation — whether it was the 21st of March or the 21st of September of the year 4004 B.C. — others, groups of educators among them, were banding themselves into a collective Saint George to save the nation from the dragon of the new science. Bishop Wilberforce publicly enquired of Professor Huxley whether it was through his grandfather or his grand-

mother that he claimed his descent from a monkey. And, amidst the uproar that followed, Huxley flung his famous retort that 'he was not ashamed to have a monkey for an ancestor, but he would be ashamed to be connected with a man who used great gifts to obscure the truth.'

Most of all the storm of controversy raged around Darwin's 'Origin of Species,' but all scientific investigation was in the air, and sound and phonetics shared the popular interest.

In that decade Sir Charles Wheatstone and Sir William Thomson (later Lord Kelvin) were concluding their researches in submarine telegraphy. The Atlantic cable was successfully laid in '66. Wheatstone, as interested in sound as in electricity, brought to London from the Continent a replica of Baron de Kempelen's automaton speaking machine, then a sensation but now gone into the limbo of forgotten and unimportant things. The great Tyndall, the first English physicist to popularize natural science, was addressing his lectures and papers to the average man in simple language. Drawing-rooms were enlivened by 'discourses on natural phenomena' and dinner tables by the feat of breaking glass tumblers by singing close to them their proper fundamental note. Stimulating as it was to the votaries of science, the sixties must have been a trying period for the owners of fine glass. One anecdote accounts for 'no fewer than twelve large glasses in succession,' the achievement of some phenomenal baritone.

Melville Bell, who was accustomed to seek for the truth, not as much as he dared, but as much as he

would, was completely and happily at home. In the admirable manner of the day his letters kept his absent sons in touch with this invigorating atmosphere of London. Presently he became Professor of Elocution at the University of London. He wrote vividly of stimulating new acquaintances there and at the Philological Society of which he was a member.

Presently the eager youngster in Elgin was writing a letter of forty pages to his father to 'communicate my discovery about resonance pitches.' Soon after, Aleck was invited to communicate his original findings to his father's distinguished friend, Mr. Ellis. [In Ellis' translation of Helmholtz, published in 1875, a footnote referred to these experiments of Mr. Graham Bell, son of Mr. Melville Bell.]

Mr. Ellis informed him, however, that his discovery had been made long before by Helmholtz.

Helmholtz, it seemed, had not only made the same observations, but had gone farther. He had built up a vowel sound from its constituents, a synthetic vowel, as it were. He had taken three tuning forks, one representing the pitch of the voice, the other two corresponding in pitch to the front and back cavities of the mouth in uttering a vowel sound, and kept the three forks in vibration by means of electro-magnets and a voltaic battery. 'The simultaneous vibration of the three forks produced one loud fundamental sound — the effect upon the ear was as though some one sang a vowel sound.'

Helmholtz had not then been translated into English, but Ellis described the experiment. He offered to lend young Bell his copy of Helmholtz'

'On the Sensations of Tone as a Physiological Basis for the Theory of Music.' But Bell could not read the German text. He could make out just enough from the plates, or thought he could, to confuse the description Ellis had given him and to conclude that Helmholtz had sent vowel sounds by telegraph. Helmholtz, of course, had done nothing of the kind. But Bell was not to discover his error for two or three years. If vowel sounds could be sent by telegraph, he argued to himself on this premise, why not consonants? Why not speech?

In experimenting with tuning forks and electromagnets, trying to reproduce an effect which he mistakenly thought well known, Bell had his first experience with electricity. Speech was the speciality of the Bell family and in order to add to his knowledge of it he felt that he must duplicate Helmholtz' results.

It was not until he secured a copy of the French edition of 'Sensations of Tone,' shortly before he left Great Britain in 1870, that Bell realized his mistake. He had been trying to repeat an effect which Helmholtz himself had not accomplished.

By that time the idea had rooted itself firmly in his mind. 'I thought that Helmholtz had done it,' Bell used to say, 'and that my failure was due only to my ignorance of electricity. It was a very valuable blunder. It gave me confidence. If I had been able to read German in those days, I might never have commenced my experiments'!

Remotely, it was the beginning of the telephone.

Meantime, his father's other London friends took an interest in young Bell's researches. With his

younger brother, Aleck was taken to call upon Sir Charles Wheatstone, and saw the replica of de Kempelen's automaton speaking machine, which Sir Charles operated in person for their edification. Sir Charles also loaned Melville Bell a copy of Baron de Kempelen's 'The Mechanism of Speech,' which explained the construction of the apparatus.

When Prince Lucien Bonaparte invited Melville Bell to bring his son to dine, however, Aleck was still boy enough to be so absorbed in the splendid table appointments, the number of footmen in the lavish green livery, the bewildering variety of the rapidly changed courses, that he heard not a word of the discussion of phonetics into which his father was plunged with their host. 'I don't remember a thing about that meal,' Bell used to laugh, 'excepting that I counted up to twenty-three courses and then I lost count.'

About this time Bell made a fast friend in another youth who was to become great, James Murray, afterward Sir James Murray, the famous editor of the Oxford Dictionary.

The Bell reputation in sound and speech, now firmly established, grew with the vogue. Melville Bell gave its gestures and its diction to the platform, the pulpit, and the stage. The amateur elocutionist was in full cry in the land, and the sales of 'Bell's Standard Elocutionist' exhausted one edition after another.

At the height of this professional success, bitter personal sorrow came to the family. In 1867, the youngest son, Edward Charles, died of pulmonary tuberculosis. He was only nineteen. The health

of the surviving sons was watched with concern. Aleck abandoned his Elgin post and took one nearer to his parents, at Somersetshire College in Bath. He remembered very little of Bath, of its famous hot springs, the baths built by the Romans and patronized by Beau Nash, but he recalled that the climate agreed with him and that he was very successful in his experiments with tuning forks. The next year he came to London to be his father's assistant; took a course in anatomy at University College — anatomy of the vocal apparatus in particular — and matriculated at London University in the same year.

It was now 1868. The tide of British lecturers which later engulfed American shores was trickling inconspicuously enough in the wake of Mr. Thackeray. They came, in those days, upon invitation, to address their cordial admirers. The year before, Mr. Charles Dickens, 'a lithe, energetic man, of medium stature,' strode across Boston platforms at the brisk gait of five miles an hour.

Like the English renaissance in design and decoration under William Morris, elocution was more than a fad of the era; it amounted to a social movement. Melville Bell was its prophet. On two continents, foreheads were clasped in despair and hands flung wide in supplication in accord with Bell's directions for the delivery of dramatic speeches and soliloquies. And in the logical sequence of fame, he was invited to come to America to give a series of lectures on his methods and his system of Visible Speech. He came as the guest of the Lowell Institute of Boston.

Aleck, now twenty-one, left in charge of his

father's London engagements, gave classes and lectures and private lessons with an outpouring of energy and enthusiasm which was characteristic of him in all his undertakings, all his life. To his passion for teaching, his abilities, and his zeal, opportunity was now added, and in his father's absence he came to his full stature professionally.

During these crowded London months he rushed from appointment to appointment, putting one pupil after another through the test sentences of his father's system — 'I see the panting spirit sigh (*not spirits eye*)'; 'All night it lay an ice-drop there (*not a nice drop*)'; demonstrating the postures approved for lecturing, for reciting, for preaching; right foot in front, weight on left foot; neck upright; chin horizontal; arms relaxed; and on and on: lecturing on Visible Speech, teaching a deaf child to speak; taking classes on anatomy and physiology at University College; reading at the British Museum; rushing out between engagements to buy some white gloves to wear as best man at James Murray's wedding.

The Lowell Institute lectures, meantime, were being warmly received in Boston. Melville Bell found that the president of Harvard was an enthusiastic student of Visible Speech. The Bell theory and its attendant handbook swept New England with effects that lasted into the nineties and beyond, and Melville Bell's personal charm made friends for him everywhere. The invitation was renewed for the autumn of 1870.

Meantime, the eldest son, Melville James, was threatened with the disease from which his younger brother had died. Early in 1870, Aleck went to

Edinburgh to relieve his brother of his teaching cares, but — just as he seemed out of all danger — Melville died with shocking suddenness.

Aleck was the only child left.

The double burden of teaching during his father's absence, and his more recent anxieties, had had their full effect on Aleck's health. His grief-stricken parents became suddenly aware of his pallor and frequent exhaustion. Distracted, they consulted the best physician in London. Their fears were confirmed. Aleck's health was seriously impaired.

It was then that Melville Bell's early visit to Newfoundland was recalled for such hope as it afforded. 'The recollection of my early experience,' he said afterward, 'determined me to try the effect of a change of climate for the benefit of my only remaining son. . . .'

His recollection was of Newfoundland, but old friends had by this time established a closer bond with Canada, and it was to the milder air of Ontario's southern peninsula that the family came. For the parents could not be separated from this one surviving child. At fifty-one, Melville Bell abandoned his London career, its professional associations and its friendships, and, very largely, the fame for which he had worked tirelessly through a lifetime of extraordinary activity, and was never to regain. Perhaps he hoped to return to London, one day. 'Our plan,' he said, 'was to give the climate a two-year trial.' But he never went back.

CHAPTER V

(1)

The Bell family sailed directly to Canada, making one of the average fourteen-day passages of steamships in the seventies, and on the eleventh day out, nearing land, got their first glimpse of a Canadian sky which William Morris described a few years later as 'clear and blue and bright and beautiful.' On the first day of August, 1870, they looked out on the shining zinc roofs of Quebec, negotiated the steep flights of steps of its precipitous landing, the unfamiliar brass baggage checks of America, and found themselves impressed by the splendours of the 'Palace Steamers' which plied, fifteen hours, to Montreal, their white paint with gilt trimmings, their velvet carpets and sofas and chairs an unexpected elegance in the colonial wilderness.

It was the month that opened the Franco-Prussian War.

In Germany, a blue-eyed American schoolgirl named Mabel Hubbard, deaf from her childhood and abroad for lessons in lip-reading, was thrilled by the magnificence of her friends' brothers and cousins in uniform. Nobody dreamed of going back to America because there was a war. She watched, ecstatically, the smartness and dash of a cavalry troop going to the front. She could see the colour and movement, but she could not hear the clatter of hoofs, or the cheering, or the band that played in the square.

(2)

The Bells stayed for a day or two in the town of Paris, Ontario, and then, 'happily led there by the accidental proximity of an old friend,' settled near the town of Brantford.

Confederation was only three years old in Canada. The provinces had not grown into any consciousness of Dominion status. Ontario was still 'Upper Canada,' and — separated by the prairies of the Northwest Territories and the peaks of the Rockies — British Columbia had not yet entered Confederation.

It was an unsettled time for the new Dominion. In a tightly buttoned scarlet tunic and immaculate white buckskin gloves, Colonel Wolseley — later a Field Marshal and a Peer of the Realm — was marching west under the hot August sun to subdue the agile half-breeds of the Red River, rebelling against the change in government from the Hudson's Bay Company to the new Federal power. The Fenian Society, an Irish organization with an anti-English programme, headquarters in the United States, and a *flair* for pillage, raided the border settlements with such regularity that the harassed provinces appointed military lieutenant-governors 'in view of Fenian aggression.' The controversy of the Alabama Claims was at its height. English plenipotentiaries yawned over the new Dominion's boundary treaties and fishery rights, making one bad bargain after another, and adding tension to the disturbed political scene. But these things were trifles to the Bell family who saw Aleck's steady improvement in this keen new air.

Brantford had been a fortunate choice. Set on the banks of the Grand River, in the heart of the old Mohawk country, 'I have seen no place within the bounds of Ontario,' said Melville Bell, 'that I would prefer for a pleasant, quiet and healthful residence.' Presently the family bought a small place on Tutelo Heights, four miles from the town. It had an unpretentious farmhouse, an orchard, a grove of birch trees, and for one of its boundaries a bend of the lovely Grand River.

Several miles farther along, another bend of the same river gave the name 'Bow Park' to a more pretentious estate. There the Honorable George Brown, a former leader of the Liberal party in Upper Canada, raised his prize shorthorns as a diversion from his political activities and from belabouring the Conservative Party through the pages of his paper, the Toronto *Globe*.

Mr. Brown, one of the great men of Canada, was a heaven-sent neighbour to a Londoner deprived of the conversation of the Philological Society and Alexander John Ellis. But it was an acquaintance that was to be nearly disastrous to the future of the frail young man at Tutelo Heights.

In after years Graham Bell always spoke of coming to Canada to die. He was fond of saying that the London specialist had given him from six months to a year to live. His recovery was remarkably rapid if this was true. It seems very much more likely that his health was impaired but not seriously undermined, for his father employed him to work on the farm for his first Canadian year. Very possibly the arrangement was designed to compen-

sate somewhat for his enforced retirement from teaching, and for the first dependence on his father since he had gone off to Elgin seven years before.

In September, Brantford heard the news of Sedan and the surrender of Napoleon III.

When Melville Bell went down to Boston later in the autumn of 1870, to fulfil his long-standing lecture engagements, all immediate anxiety for his son's health was past.

At the end of this Boston engagement, Melville Bell was invited to give a further series of lectures on Visible Speech, especially addressed to teachers of deaf children. He had accepted teaching engagements in Canada, however, and was obliged to return to his classes there, so he suggested that a little later, when his health should be fully restored, his son should be invited instead.

Alexander Graham Bell was then only twenty-three, but in the seven years since his initial venture at Mr. Skinner's Academy, he had compassed the reading, study, and teaching experience of many a lifetime. Not only had he been entirely independent for these seven years, but for nearly three of them he had been full partner in his father's professional work in London. Obviously he was a fully qualified substitute for his father in the proposed lectures. And through the efforts of the School for the Deaf — the institution that afterward became the Horace Mann School — the Boston School Board was prevailed upon to vote five hundred dollars for fees; the invitation was directed to Alexander Graham Bell, and in April, the first week of April, 1871, he came.

(3)

The Boston to which Graham Bell came in '71 was the Boston that dined at five o'clock, drank tea for breakfast, classed lectures as amusements, and took out-of-town guests to the Old Corner Bookstore as a memorable event of their visit. Some literary celebrity was sure to be browsing along the shelves, Mr. Longfellow, Mr. Emerson, Dr. Holmes, or even Mrs. Julia Ward Howe. Thomas Wentworth Higginson says that very often they were all there at the same time.

It was the Boston to which a well-known florist hurried back from a short holiday, upon hearing of the death of a prominent citizen, 'because it would be more trying for the family to order from a clerk the flowers for the funeral.'

Its best citizens felt, with the *Atlantic Monthly* in that year, that they owed it to society 'as rich, well-educated people, to keep on living simply and sanely in the tradition of their ancestry.' 'They may be thought dull, if they must; they may be as exclusive as they like, if only they will impress the fact that the highest social position implies virtue, sobriety and culture.'

'Anti-monopoly' wrote to the newspapers, protesting the lack of seating accommodation in the horse-cars. In Boston, as elsewhere, it was the era of gas-lighting, the era that gave hair-wreaths, wax flowers, pampas grass in vases, and framed steel engravings to the American interior. Rubber plants basked in the bow-windows of Beacon Hill. Gentlemen parted their hair behind, and had all creases pressed out of their trousers so that they hung with

flawless symmetry of twin stovepipes. Ladies wore heavy gold lockets upon their bosoms, did worsted work, and though Monday Clubs and Rainy Day Clubs and Browning Societies were everywhere, though Lucretia Mott was still alive and Susan Anthony campaigned for Woman's Rights, members of their sex were still described, with the detail that is born of novelty, by a startled press when they rose to speak in public.

It was the year that P. T. Barnum launched his 'Greatest Show on Earth,' when Joseph Jefferson appeared in 'Rip Van Winkle,' and when the American Institute of New York joined with the Franklin Institute of Philadelphia and the Legislature of Pennsylvania in petitioning Congress for aid in setting afoot a great world exhibition to mark the Centennial year of the Republic in 1876.

Bell spent two months in Boston during his initial employment with the School for the Deaf, and afterward went up to Northampton to repeat his lectures at the Clarke Institution for deaf mutes. It is now the Clarke School. At intervals in the next year, while making his headquarters with his parents in Brantford he also visited the Asylum for Deaf Mutes at Hartford, where he taught for some weeks, and then spent two months at Newton Lower Falls, as the guest of Miss Sarah Fuller (principal of the Boston School), where he took some private deaf pupils. In August, Bell went to a national conference of principals of institutions for the education of the deaf, at Flint, Michigan, where he made a lucid address on 'Speech.' 'Speech,' he said, 'is a mere motion of the air.' He was then twenty-five.

(4)

That year, as a Canadian, Bell voted for a Mr. Paterson, who was elected Mayor of Brantford. In later years, as an American citizen, Bell's residence in the District of Columbia deprived him of the franchise, and he remembered this occasion as the only time in his life that he ever cast a ballot.

The reservation of the Six Nations Indians near Brantford was a happy hunting ground for the young enthusiast in Visible Speech. When he wasn't doing anything else that year, Aleck devoted himself to an analysis of their language. The flattered Mohawks later received him into the tribe as a tribute to his interest, and when a lady cousin came to visit Tutelo Heights, Aleck got dressed up in the ceremonial costume of Indian Chief Johnston, and posed with her for a photograph. The cousin was satisfied with a red blanket draped over her smartly knife-pleated flounces and a pipe of peace held conspicuously into the camera. Her heart wasn't in it. Bell, however, with a strong sense of the theatre, looked thoroughly happy, and as warlike as he could considering the hybrid nature of the costume — fringed elkskin, beaded ornaments, and ostrich plumes. From this pleasant acquaintance with the Six Nations, Bell emerged also with the war dance which he habitually performed thereafter in moments of triumph, and which was so little appreciated by later Boston landladies.

(5)

During his first Canadian winter, Graham Bell had resumed some of his old experiments with tuning

forks, based on the work of Helmholtz. The harmonic, or multiple telegraph, was beginning to take form in his mind. He spent hours in the little drawing-room at Tutelo Heights, singing a single note into the piano, his foot on the pedal, listening for the answering vibration of the corresponding key. The Bells lived very quietly, but they were liked in Brantford, and there was a distinct note of regret in the rumour that presently got about that the son — such a nice young man too — was just a little peculiar.

(6)

In October, 1872, Bell returned to Boston, took rooms at Number 35, West Newton Street, and 'opened a school of vocal physiology.'

His announcement read in part:

> For the correction of stammering and other defects of utterance and for practical instruction in visible speech, conducted by Alexander Graham Bell, member of the Philological Society of London.

He began to send his little manuscript periodical, the *Visible Speech Pioneer*, which he edited himself, to schools employing the Melville Bell Symbols, and he wrote industriously on the subject for print.

In a previous school vacation, Sarah Fuller had given a few weeks' instruction to a child of five who had been born deaf, the son of Thomas Sanders, Esquire, of Haverhill. She introduced Bell to Sanders, and it was arranged that Bell should undertake the child's education with the help of his assistant, Miss Locke. Little George Sanders was

sent, with his nurse, to live at Bell's boarding-house, so that he might have constant teaching supervision.

Rather later, Mr. Gardiner Greene Hubbard, a prominent Boston lawyer, became interested in Bell's School of Vocal Physiology. Hubbard had long been a champion of oral teaching for deaf children. His daughter Mabel had lost her hearing from scarlet fever at the age of four and a half. Although able to save his own child from the isolation of a sign-language institution by having her taught privately, Hubbard crusaded for years in the State Legislature for the privilege of speech for other deaf children. There was no widespread interest in the education of the deaf at that time. It was generally felt, when the matter was considered at all, that to teach speech to deaf mutes was to undo the work of the Creator; that if God had intended deaf mutes to talk, He would have given them that power.

Gardiner Greene Hubbard was in his fifties when Bell met him. He was the grandson and namesake of that Gardiner Greene who was considered the richest man in Boston in his day. He had practised law for twenty years in Massachusetts, and his frequent Supreme Court cases took him regularly to Washington during Congressional sessions. He had been instrumental in bringing to Cambridge and Boston the first street railway outside of New York, had been president of that concern and of the Cambridge Gas Light Company. For ten years he had been on the State Board of Education. Later, Hubbard became a Regent of the Smithsonian Institution, and a founder and the first president of the

National Geographic Society. His interests were legion and his energy and enthusiasm boundless, whether — as periodically happened — he was making a fortune or losing one. The chances he took — and they were many — were always in the direction of progress. Nowadays he might be called a promoter, and it was in that rôle that he played an important part in the development of the telephone.

In Bell's early years in Boston, Mr. Hubbard consulted him about the instruction of his daughter Mabel, then back from school in Germany. There she had become adept in reading speech from the lips.

Mabel Hubbard was never Bell's pupil in the strict sense. Her mother was anxious to have her receive lessons to improve her speech, and Bell directed her teacher in the use of Visible Speech, and was sometimes present at her lessons. But he did not teach her himself. In later life, however, he abandoned the distinction about which he was once particular and spoke of her as 'coming to me as a pupil.'

Fiction can add nothing to the love story of Alexander Graham Bell and Mabel Hubbard. In its simple chronicle of fact it has all the elements of romantic young passion as done into the well-worn story-book prose. She was young and lovely and rich. He was brilliant and ardent and poor. They were to encounter the obstacles of parental displeasure, of discouragement, and even ridicule of his genius. All these familiar notes progress to the old familiar finale of fame and fortune and a happy ending. They were to spend a long, happy life together.

To Bell's romantic and ardent mood Mabel Hubbard's deafness was only one more challenge of fate, one more obstacle to be taken in his impetuous stride.

It is as thoroughly unspoiled and charming as a story can be, and needs no props from art. A popular version, however, has erroneously made the telephone a direct result of Bell's efforts to give hearing, or a substitute for hearing, to Mabel Hubbard. She was, of course, studying articulation under his direction during his early work on the telephone, and their later love affair was to influence profoundly the development of Bell's invention. But the first experiments to 'devise an apparatus that might help deaf children' were, by Bell's own account, initiated by his earlier work at the Horace Mann School. These experiments led directly to the speaking telephone.

'As a student of the mechanism of speech,' Graham Bell once said, 'familiar with it from my childhood, this subject in fact having been the professional study of my family for three generations, I realized that deaf children whose vocal organs were perfect could be taught to speak'; but he was sceptical about lip-reading.

In 1894, the Horace Mann School of Boston celebrated its twenty-fifth anniversary. Bell came on and made an address. He spoke of his deep personal interest in the school, which had been the means of bringing him to the United States. Speaking of his early incredulity of the value of lip-reading to the deaf, he said:

'My original scepticism concerning the possibility

of speech reading had one good result: it led me to devise apparatus that might help the children . . . a machine to hear for them, a machine that should render visible to the eyes of the deaf the vibrations of the air that affect our ears as sound. . . . It was a failure, but that apparatus, in the process of time, became the telephone of to-day. It did not enable the deaf to see speech as others hear it, but it gave ears to the telegraph, and to-day we hear in Boston what is spoken in New York and Chicago.

'I trust,' Mr. Bell concluded apologetically, 'that you will pardon personal allusions to my own work. It is only right that it should be known that the telephone is one of the products of the work of the Horace Mann School for the Deaf, and resulted from my attempts to benefit the children of this school.'

(7)

All during the winter of 1872–73, Bell burned his candle at both ends. He gave lessons in speech by day, and at night he pushed his experiments with tuning forks, the experiments which resulted presently in the harmonic or multiple telegraph — the forerunner of the telephone.

The room next to Bell's in the adjoining house was occupied by a young man named Richards, who affably permitted a wire to be strung from Bell's window to his own. Obligingly, Richards listened to Bell's signals, wondering what it was all about. He was to remember, chiefly, Bell's excitement when he got the effect he wanted. In those days there were always people, like Richards, who would let Bell string wires on their premises, who would make up a

human circuit for him by clasping hands in a row, and fill their ears with water to listen for an electrical effect; all because he was such a very engaging young man, even if he was, regrettably, a little mad.

His apparatus he made 'with my own hands, even to the winding of the electro-magnets, as I was afraid to employ an electrician or mechanician, until the telegraph could be secured to me by letters patent.' While Newton Street slept, Bell adjusted and readjusted the apparatus, patiently, very clumsily — for Bell was never deft in the use of his hands — and when the milkman came clattering down the cobbled street, with the sunrise, he went to bed for an hour or two.

Miss Sarah Fuller, the brilliant principal of the School for the Deaf, helped to keep his accounts in order. She had been instrumental in having Bell invited to Boston, and doubtless felt some responsibility for his present venture. She gave him good advice, and she darned his socks. Nevertheless, for all her interest, his work seems to have been the only thing that Bell attended to with any regularity. He ate as infrequently as he slept, and in the spring of 1873, he was a wreck. In May, he went home to Brantford, to his mother's anxious care, and the peace of Tutelo Heights.

CHAPTER VI

(1)

When Bell came back to Boston in October, 1873, it was to live at the Salem house of Mrs. Sanders, the grandmother of his little pupil.

The relation of Thomas Sanders to Bell was very much that of the historic patron who exclaimed to his protégé, 'Which of us is the happier — I who have found such an artist, or you who have found such a prince?' Only Bell's inspired teaching was saving a loved child from the isolation of deafness, and very soon Thomas Sanders' generous aid was to save the child of Bell's brain.

Essential as Bell's teaching was to George Sanders, the earlier living arrangements at Bell's Boston lodgings had been unsatisfactory for such a little boy. Yet he was too young to make a journey to Boston every day for his lessons. His grandmother lived in Salem, fourteen miles from Boston. It was an hour's journey by train. So it was arranged that Bell and the little boy should come to Salem, where his pupil could have regular supervision, while Bell could still keep his daily engagements in Boston. Considering the Sanders' problem, and Bell's narrow means — which doubtless figured discreetly in the invitation — it was a very happy solution.

Mrs. Sanders lived in a roomy, white clapboarded, green-shuttered New England house, built ten years before the War of Independence. Across the roof, above the third-storey dormer windows,

ran the staunch wooden railing, typical of New England seaport houses, where some retired skipper had once levelled his glass out to sea, picking up the distant topsails of ships making port, following the clippers breaking out their last inch of canvas, outward bound in the China trade. Set in its tree-shaded, trim lawn, this Essex Street house was Bell's home, excepting for his summers in Brantford, from the winter of '73 to January, '76.

The big basement was fitted up for his use as a workshop, and here Bell spent his leisure in a clutter of wires, batteries, and tuning forks. Ultimately Mrs. Sanders turned over to Bell the entire third floor, and wires ran down the stairways to the basement workshop.

George Sanders' little brothers were to remember that when they visited Grandmama Sanders, they slept two in a bed, because Mr. Bell had the whole top floor for his own; that he always came down late to breakfast (and played 'bear' with them while he ate). Sometimes he worked, uninterrupted, for days on end, while his meals were carried up and slipped inside his door on trays, and when this happened, Mrs. Sanders cut his candles shorter than the others, because when they burned out he would have to go to bed!

Bell took a room in Boston, at 18, Beacon Street, in a building of the Boston University, to which he commuted daily for his speech-teaching work. He also lectured that winter at the School of Oratory of Boston University, where he was 'Professor of Vocal Physiology.'

The relation between the teacher and his little

pupil gives an attractive picture of the twenty-six-year-old Alexander Graham Bell. George Sanders was a particularly lovable, intelligent child, very quick mentally. And Bell was an inspired teacher. The little boy had been born deaf, had never spoken, and, although Bell taught him to speak, he did not then employ lip-reading, but devised a method of finger-spelling of his own. He had a small glove for George's hand, with letters and words inked on it, and through this medium the two held animated conversations. Bell took him to see the lions at Barnum's show. He played lesson games with him. He told him every story he could think of, and when he had taught the little boy to read, Bell copied in his own clear hand a small book of stories for him, using words of different sizes to convey the emphasis which the child could not hear.

In the late afternoons, George would stand at the window, watching for Bell's tall figure, wait for him to wave his hat, and rush to meet him at the door with the precious lettered glove.

Then, leaning on Bell's knee, he was told all about the exciting events of the day. To Bell, all days were full of exciting events. He made a thrilling story about the monkey he saw in Tremont Street, the little dog that followed him for three blocks, all about the runaway horse in the horse-car and the lady who carried the parrot in the train — using every picture suggested by his own eager sympathy to dramatize life's movement and colour for a little boy shut out of a hearing world. And then, when George's bedtime came, Bell went down to his workshop and lost himself in his harmonic telegraph. He

continued to make change after change, adjustment after adjustment, in the hope of producing a working model of a device which he knew to be sound in theory.

(2)

He thought, Bell said afterward, that a model was necessary in order to obtain a patent in the United States, and yet to obtain a satisfactory model he must entrust his idea to 'some mechanician who might take advantage of his practical knowledge to checkmate me in the Patent Office.' To safeguard this a caveat might be filed, but Bell understood that a caveat 'could not be procured in the U.S. Patent Office by a British subject.' 'Not knowing how to protect my interests in this country,' he explained afterward, 'I resolved to offer my invention to the British Government.'

He wrote to the Honorable Mr. Scudamore, Superintendent of Telegraphs in England:

292 Essex Street
Salem, Mass., *Jan.* 10, 1874

Sir:

I have invented a method by which a large number of telegraphic messages can be sent along the same wire, at the same time, without confusing with one another.

[Diagram and 4 lines of description]

As I am a British subject I wish to place this idea at the disposal of the British Government, and therefore, before making any efforts to interest American telegraphers in the scheme, I write to request an investigation.

Yours respectfully

A. Graham Bell

Professor of Vocal Physiology in the University of Boston, Mass.

If this letter reached Mr. Scudamore, he must have been impressed at least by its clear brevity, even though it was automatically routed to the desk of the gentleman who took care of inventors for the Government of Great Britain. There was, and obviously had to be, a form letter for these loyal offers. It was sent off promptly. 'An answer was received from the Post Office Department in London,' Bell comments, 'which effectually prevented any further correspondence.'

GENERAL P. O. *22nd Jan.*, 1874

No. 11, 566
SIR:

With reference to your letter of the 10th inst. I beg leave to inform you that if you will submit your invention it will be considered; on the understanding, however, that the department is not bound to secrecy in the matter, nor to indemnify you for any loss or expense you may incur in the furtherance of your object, and that in the event of your method of telegraphy appearing to be both original and useful, all question of remuneration shall rest entirely with the postmaster general.

I am, sir, your obedient servant

JOHN TILLY

A. GRAHAM BELL, ESQ., No. 164
292, ESSEX STREET, SALEM

(3)

It was in the early part of 1874, while having a piece of apparatus made for him at Charles Williams' shop in Boston that Bell met the young electrician who was to be his future assistant and co-worker on the telephone, Thomas A. Watson.

In one of his public lectures Watson has given a vivid description of the encounter:

One day when I was hard at work . . . a tall, slender, quick-motioned man with a pale face, black side-whiskers, and drooping moustache, big nose and high sloping forehead crowned with bushy black hair, came rushing out of the office and over to my work bench. It was Alexander Graham Bell whom I then saw for the first time. He was bringing to me a piece of mechanism which I had made for him under instructions from the office. It had not been made as he directed and he had broken down the rudimentary discipline of the shop in coming directly to me to get it altered.

It was a receiver and a transmitter of his 'harmonic telegraph,' an invention of his with which he was then endeavouring to win fame and fortune. It was a simple affair by means of which, utilizing the law of sympathetic vibration, he expected to send six or eight Morse messages on a single wire at the same time, without interference.

In 1874, there were none of the great electrical workshops of to-day. The chief use of electricity was in telegraphy and in fire-alarms, as Watson points out, and there was no such thing in any university as a course in electrical engineering. The scanty electrical apparatus in use was made chiefly in such small shops as Williams', and to such shops inventors brought their new electrical notions. Watson says, 'There were often two or three of them there at the same time, feverishly superintending the construction of their machines, spurred on by visions of boundless wealth.' This superfluity of genius seems to have made for a certain hardy cynicism in Williams' shop.

In Watson's autobiography he modestly explains that most of these inventors and their devices were sent to his bench because he was a rapid worker.

His alert mind and even temper probably had as much to do with it. In the narrative of his work with Bell which later occupied his full time, Watson says, 'No finer influence than Graham Bell ever came into my life.' If he owed much to Bell, it is no less true that Bell owed much to him. Bell was peculiarly helpless in doing anything with his hands. Yet Watson gave more than his services as a skilled mechanic to the invention of the telephone. He had an unusually quick intelligence, and his imagination, enthusiasm, and loyalty were assets as valuable to the temperamental Bell as were industry and skill. Watson's serenity, sympathy, and zeal were added to Bell's genius in an auspicious hour.

Watson has given a delightful picture of Bell, and of himself, in his autobiography, 'Exploring Life.' Watson was twenty, in 1874, seven years younger than Bell. Of Bell he says:

> He was the first educated man I had ever known intimately and many of his ways delighted me. His punctilious courtesy to every one was a revelation. The books he carried in his bag lifted my reading to a higher plane. He introduced me to Tyndall, Helmholtz, Huxley, and other scientists of whose writings I had been ignorant until then. He scolded me for dropping my algebra and bought me the latest book on the subject he could find.

Probably unconsciously, Bell was assuming his happiest rôle, that of teacher, with his young assistant. He took Watson to supper at his boarding-house, and the embarrassed youngster did his best to copy Bell's elegant manner of eating with a fork. Afterward he watched with admiration and awe while Bell played the piano.

But the best thing Bell did for me [Watson says] spiritually — was to emphasize my love of the music of the speaking voice. He was himself a master of expressive speech. The tones of his voice seemed vividly to colour his words. His clear, crisp articulation delighted me and made other men's speech seem uncouth. When he learned of my interest in speech tones, he was surprised and pleased and gave me some of his father's books on elocution. All of which I keenly appreciated and practised diligently on my poems on my Sunday walks.

(4)

While Bell worked at night on the harmonic telegraph, with every teaching day he thought more and more about an apparatus by which his deaf pupils might see speech.

Now in teaching a deaf child to speak — that is, in teaching him to take consecutively the positions of sounds, then to combine the sounds into words, and so slowly to arrive at speech — Bell found that there was no means of teaching the quality or inflections of the voice. Children with normal hearing acquire these variations, as all speech is normally acquired, by unconscious imitation. The deaf child cannot imitate what he cannot hear. It is the lack of this inflection in the speech of persons deaf from birth or early childhood that makes their voices characteristically unmodulated, often disagreeably harsh.

Bell knew of a device, invented by Koenig, called the 'manometric capsule.' In this apparatus, an enclosed gas flame was made to vibrate by the action of the voice. The vibrations of the voice, acting on a membrane so as to compress or expand the gas flame, produced a flickering — like the teeth of a saw —

that was characteristic of the sound. 'The flame moved up and down just as many hundred times a second as the voice vibrated.' A revolving mirror reproduced the flickering of the flame in a continuous wavering band of light. Bell thought 'that if I could discover the shape or form of vibration that was characteristic of the elements of English speech, I could depict these upon paper by photographic or other means for the information of my deaf pupils. Suppose, for example, that I could present to a pupil a photograph of the undulations produced by uttering into the instrument the vowel *e*. I could then get the deaf child to make sounds into the mouthpiece of the manometric capsule and observe the forms of the flame undulations thereby produced. He would then know that he was sounding the vowel *e*.'

This was undoubtedly sound in theory, but it was like catching a bird by putting salt on its tail. Bell borrowed the manometric capsule from the laboratory at the Massachusetts Institute of Technology, probably from Professor Charles R. Cross, who gave him much helpful advice. But the difficulties of photographing the flickering band of light defeated such a simple answer to the problem.

Then Bell turned his attention to the phonautograph of Leon Scott. The phonautograph, as its name indicates, was a sound-writer. A Mr. Morey, a student at the Massachusetts Institute of Technology, had recently made an improvement in Scott's phonautograph, and hearing of Morey's improvement Bell went over to the Technology building to look into it.

Briefly, the phonautograph consisted of a

stretched membrane, a long, light lever of wood attached to the membrane, a bristle on the extremity of the lever, and a conical mouthpiece. A plane sheet of glass covered with lampblack was so arranged that, when a sound was uttered into the mouthpiece and its vibrations thus communicated by the stretched membrane to the wooden lever, the bristle wobbled up and down, tracing its motion on the lampblack surface. The sheet of glass was arranged to move along at a uniform rate, recording the vibration thus made. The barograph barometer works very much after the same fashion.

Bell decided that these lampblack records could be used as negatives. He could, he thought, print off copies of these tracings for his pupils. With one of these photographs before him, Bell thought, the deaf child could then 'make sounds into the mouthpiece of the manometric capsule until he could produce flame vibrations of a similar shape to the one on the photograph.' Presumably he would then be uttering 'a similar sound to that which had been uttered into the cone of the phonautograph when the tracing was originally made.'

Day after day, while the trees on Boston Common budded and then burst into leaf in the spring of 1874, Bell strode across to the Technology building to sing one vowel sound after another into both pieces of apparatus. The Massachusetts Institute of Technology was then less than ten years old. Its students numbered under three hundred, and all its activities were housed in a single 'elegant structure of pressed brick with freestone trimmings.' Afterward Bell saw there the receiver of the Reis tele-

phone, which was to be deliberately confused with his own electric speaking telephone by later rivals.

Bell sang his resonant *e* first into the phonautograph and then into the manometric capsule. Theoretically the band of flame and the lampblack graph should have been exactly alike. But they weren't. They varied perversely. Bell decided that the trouble was in the phonautograph. It had a vibration of its own which threw out the perfect record of his vowel *e*. So he set to work to improve the apparatus for himself. And every change of adjustment, and of levers, and membranes, was a miserable failure. Furiously, Bell ran his hands through his thick black hair and started all over again.

All of this time Bell was giving his lectures at Boston University, maintaining his class-room in Beacon Street, and going back nightly to the Sanders house in Salem, where an eager little boy flattened his small nose against a window-pane, watching for the tall figure hurrying up the street.

(5)

If Bell's genius can be identified with any one mental characteristic, it is with the extraordinary lucidity and independence of his thinking. It was the trait he inherited from Alexander Bell. With any subject he approached, he went back to the rudiments and worked out his hypothesis from there. Once he had the facts or first principles, he formed his own conclusion. And when he had formed it he stuck to it with the tenacity of ten men.

As lesser men have had, Bell had the faults of his virtues. He was to lose years of time, long after-

ward, in independently compiling and tabulating information which was the commonplace of physics, often the common knowledge of any schoolboy. His passion for proving everything for himself was the despair of later associates. But he never forgot that this trait, plus his own tenacious purpose and faith, had led him to the invention of the telephone.

When the existing phonautograph failed him, Bell's mind took one of its characteristic shots, straight to the root of the problem. 'I was struck,' he said, 'by the likeness between the mechanism of the phonautograph and the human ear, the membrane of the one being loaded by a lever of wood, and the membrane of the other by levers of bone. It appeared to me that a phonautograph modelled after the pattern of the human ear would probably produce more accurate tracings of speech vibrations than the imperfect instrument with which I was operating.'

Could anything be simpler?

Sometime in the autumn of 1871, Sarah Fuller had introduced Bell to the brilliant young Dr. Clarence J. Blake, afterward famous among American otologists (as the aurists of the seventies were afterward called). Dr. Blake, then twenty-eight, was four years older than Bell. Lecturer on Otology at Harvard and aural surgeon at the Massachusetts Eye and Ear Infirmary, he had been consulted as an expert in sound production and questions of hearing by the Committee of the Boston School Board when that body was weighing the expenditure of five hundred dollars and the invitation to young Mr. Bell.

Now that Bell wanted some expert advice in re-

producing the structure of the human ear, he went to call on Dr. Blake.

Bell has told the circumstances: 'I told him that I wanted to get a phonautograph modelled after the ear, and he quite startled me with the suggestion — "Why not take an ear from a dead man and get tracings from the little bones of the ear?"'

The idea fascinated Bell. Where could he get a human ear? Blake volunteered his professional services, and 'went to the Harvard Medical School to get it.' Fortunately, as it developed later, Blake was so interested in the idea that he not only had an ear from a dead subject prepared for Bell's use, but secured one for himself. For nearly a year the two men kept in touch with each other, exchanging notes on their experiments. It was fortunate, because Bell had not then learned the bitter lesson that litigation had in store for him, and thought little of the value of contemporary notes. It was a lesson which, once learned, burdened all his later work, until the dating and signing of the most insignificant record became an obsession. And, as in the case of so many fixed prejudices, it had its source in painful experience. It was a trifling circumstance in the interchange between Bell and Blake that later provided the only evidence of a year's consecutive experimenting.

'It so happened,' Bell says of the next step with the human ear, 'that it was not far from the summer vacation, and so I carried this ear up with me to my father's house in Brantford, and there I commenced to make experiments.'

He moistened the ear with glycerine to make it flexible, attached a small piece of hay as a substitute

for the bristle of the phonautograph, and when he spoke into the membrane of the ear he saw the hay vibrate. Then he arranged a piece of smoked glass to move, by an attached weight, and began to study the tracings of the vibrations characteristic of the different elements of speech. He shouted vowels, all on the same pitch and at different pitches, *e*, *a*, *ah*, and watched the tracings made on the smoked glass.

Each of the vowels under these circumstances was characterized by a different form of vibration, but what did that different form signify? It was the equivalent of what we call the quality of the voice.

Now it so happened, that while I was experimenting with this human ear, I was at work on a very different problem. I was at work on a problem of transmitting musical sounds by a telegraphic instrument, by an intermittent current of electricity, and I had dreams that we might transmit the quality of a sound if we could find in the electrical current any undulations of form like these undulations we observe in the air.

I had gradually come to the conclusion that it would be possible to transmit sounds of any sort if we could only occasion a variation in the intensity of the current exactly like that occurring in the density of the air while a given sound is made.

If you were to take a phonautograph tracing of, we will say the vowel *ah*, you would have a vibration of a certain shape. If you could get an electrical current in which that would cause variations, you would get a current that would transmit the whole *ah*.

I had reached this idea and had gone a step further. I had obtained the idea that theoretically you might, by magneto electricity, create such a current. If you could only take a piece of steel, a good chunk of magnetized steel, and vibrate it in front of the pole of an electro-magnet, you would get the kind of current we wanted. . . . . . . it struck me that the bones of the human ear were

very massive, indeed, as compared with the delicate thin membrane that operated them, and the thought occurred that if a membrane so delicate could move bones relatively so massive, why should not a thicker and stouter piece of membrane move my piece of steel. And the telephone was conceived.

Bell's phraseology varied in trifling ways, his examples differed occasionally, but this description of 1916, when the telephone was forty years old, is characteristic of the story as he was accustomed to tell it. 'The conception of the telephone,' he added, 'took place during that summer visit to my father's residence in Brantford, in the summer of 1874, and the apparatus was just as it was subsequently made, a one-membrane telephone on either end.'

CHAPTER VII

(1)

While the marriage of Miss Jennie Jerome and Lord Randolph Churchill stirred New York and London, the summer of 1874 was a red-letter season in Canada. Lord Dufferin, the Governor-General, with his lady and *entourage*, toured the newly confederated provinces, riding under evergreen arches, bowing from garlanded platforms hung with flags and bird cages, receiving tirelessly the loyal speeches of perspiring mayors and the bouquets of self-conscious little girls in starched dimity; graciously recognizing the spirit of Empire in the earnest if rather overheated exertions of the flesh.

From one welcoming arch in Ontario, by a triumph of management, a cheese was lowered into their carriage and deposited at the feet of the delighted Vice-Regal pair. Brantford decked its brow with loyal evergreens and turned out in its best clothes with the rest. 'An indefatigable band,' said Lady Dufferin, 'played the whole day and evening.' The family at Tutelo Heights went into town to see the guard of foot and horse, the parade of school-children, to watch the Governor-General turn a sod of the new railway (the Canadian Pacific), and to see the beautiful Lady Dufferin lay another cornerstone. A gentle little old lady in a black silk gown, six yards 'round the bottom, held the arm of her tall son and was reminded — if only figuratively — of the dear Queen.

In its brief jottings Melville Bell's diary outlines the events of that summer. On July 11 he noted, 'Aleck home.' One wonders whether Aleck's mother knew of the horrid relic which was included in the clutter of wires, tuning forks, and batteries, comprising the bulk of her son's luggage.

He got home on Saturday, and on Tuesday was 'off to Belleville' to a convention of teachers of the deaf. A week later he was back in Brantford. Thereafter, day after sunny day, through July to late September, he smoked new plates for his apparatus, shouted and sang into the membrane of the human ear, and dashed downstairs from time to time with a new tracing to show. His mother watched him anxiously. Of course the experiments were very interesting. But there he sat in his hot little bedroom under the eaves, shouting *e*, *ah*, *a*, by the hour, and, though he did not disturb her, because she could not hear him, she wished that he could be persuaded to spend more time out-of-doors.

On July 26, Melville Bell's diary noted a conversation with his son. The entry ran: 'New Motor (hopeful). Electric Speech (?)'

The query was conspicuous and significant.

In one early September entry the father notes: 'Aleck in tantrums. Full of new schemes.' Three weeks later, 'Aleck left.'

(2)

Bell took his new schemes with him, and presently he communicated the most startling of them to Mr. Thomas Sanders. This was a scheme to send speech over an electrified wire.

Sanders, whose enthusiasm seems to have been second only to Bell's own, had already financed Bell's experiments to a considerable total, and about this time offered to back him further so that he could finish the multiple telegraph. Soon after Sanders made this offer, Bell paid a visit to the Hubbard house in Cambridge. He was playing the piano, stopped suddenly, and said to Mr. Hubbard, 'Do you know that if I depress the pedal and sing a note into this piano, that the piano will respond with the same note? That if I sing "do," the piano will return "do"?' Mr. Hubbard did not know it. Politely he put down his book and enquired further. Bell explained his theory of the harmonic or multiple telegraph. Nothing could be more typical of Bell's instinct for good theatre than this stopping in the middle of a sonata to make his point more effective. He would have made a superb press agent. The incident resulted in an offer from Hubbard to share the expenses of Bell's experiments. Sanders, who was entirely willing to assume the expenses alone, consented to the joint arrangement to please Bell.

Later, Bell found that his backers did not understand, as he did, that the speaking telephone was included in the inventions covered by their agreement of 1874, 'which might account,' he said, 'for the little encouragement I received to spend time on experiments relating to it. Even as late as 1876, when the telephone was an assured success, Mr. Hubbard generously offered to relinquish to me all right and title to that invention, as he was inclined to think it was outside our original agreement.'

In the autumn of 1874, his school opened to an un-

expectedly large enrolment, and his lectures at Boston University were largely and enthusiastically attended. On October 20, going home to Salem by a midnight train, Bell wrote to his parents: 'I am to-night a happy man. Success seems to meet me on every hand. First pupils pour in . . . Second, the Medical Society has evinced great interest in the ear experiments . . .'

Members of the Society had made helpful suggestions and had asked him to repeat the experiments 'with a fresh specimen.' It was only the beginning of helpful overtures to Bell from Boston men of science which he always acknowledged with gratitude. He was busy with a lecture on 'The Education of the Deaf' to be delivered the next Wednesday at the Massachusetts Institute of Technology. He had taken preliminary steps to become an American citizen. He was preparing the specifications covering his ideas in multiple telegraphy.

Thomas Sanders said of this time, when visiting at his mother's house, 'Often in the middle of the night Bell would wake me up, his black eyes blazing with excitement. Leaving me to go down to the cellar, he would rush wildly to the barn and begin to send me signals along his experimental wires. If I noticed any improvement in his machine, he would be delighted. He would leap and whirl in one of his war dances and then go contentedly to bed. But if the experiment was a failure, he would go back to his work bench and try a different plan.'

At the beginning of that autumn, Bell felt that only a matter of a few weeks, or, at most, a few months, must intervene before his combination of

tuned reeds would be ready to revolutionize the telegraph industry, sending six or eight messages at the same time over a single wire where then only two could be sent simultaneously. Previously only one message at a time could be sent over a single wire, and for the device which doubled that capacity, so Bell was told, a telegraph company had paid seven hundred and fifty thousand dollars! And his invention would send six or eight messages instead of two. By its sale to the Western Union, that colossus of corporate bodies, every one pointed out that he would be 'made for life.'

(3)

Bell had by this time become an accustomed visitor in Cambridge to the Hubbard house on Brattle Street. Brattle Street — once 'Tory Row' — was the show street in Cambridge. It stretched, broad and tree-lined, for more than a mile to the cemetery of Mount Auburn, past the Longfellow mansion, a large, square wooden house, painted yellow, long ago confiscated from a 'Tory' colonel to be used as Washington's headquarters. Little Mabel Hubbard, carrying a bouquet of the gardener's best pink roses, once made her timid approach to its elm-shaded verandah to ask the poet's autograph in a gift copy of his works, and when he had written it, he added the verse beginning, 'Maiden with the meek brown eyes.'

In the seventies the Hubbard house stood in five and a half acres of its own grounds, grounds long since subdivided and built upon. Its lawns and shrubberies, its hothouses and greenhouses and

grapery were evidence of the substantial Hubbard means, and so was the spectacle of Mr. and Mrs. Hubbard driving out in the late afternoons behind the shining black horses, Thomas in livery on the box.

Sometimes on Sundays Bell came to Brattle Street to dinner; the unvaried midday Sunday dinner of roast beef, with floating island, flavoured with almond, for dessert. The Hubbard dining-room, in advance of the times, had a marquetry floor of diamond-shaped pieces of light and dark wood. Over the dining-room table glittered the myriad glass pendants of the gas chandelier, and its duplicates, in miniature, held candles at each end of the marble mantelpiece. On a marble shelf stood that hardy American perennial, the glass pitcher of ice water. Inherited mahogany saved the Hubbard household from the black walnut and horsehair horrors of the era, but not from the sepulchral vogue of marble-topped surfaces. There was a big iron safe in the dining-room and that had a marble top too. The red velvet paper on the walls vied with the 'crimson velvet splendours of the parlour' described by an earlier visitor. Altogether it was a scene so elegant that it seemed to Bell as a great gulf fixed between Mabel Hubbard and his penniless addresses.

There were four very pretty daughters. Mabel (May to the family) was the second. The eldest, Gertrude, eight years May's senior and so very nearly Bell's own age, was a young lady of such bewildering beauty and fascination that for a long time the susceptible Bell did not know with which sister he

was in love. Grace and Berta, aged fourteen and sixteen, mimicked Bell wickedly, impersonating his formality, his punctilious language, in which speech was 'utterance' and slang a more serious breach than profanity, his rather elaborate manners, and his old-fashioned coats. And when this pale, serious, impetuous young man began to fall in love with Mabel, her little sisters teased her gleefully. 'Call me pet names, dearie,' they sang, 'Call me Aleck!'

(4)

Bell had found time, that October, to call upon Dr. Blake to tell him of the startling conception which had resulted from the use of the human ear. A pad of prescription blanks lay on Blake's desk. The physician had made some experiments with the duplicate member, and as they talked they drew pencilled tracings to illustrate their results. Idly, Blake fastened them together with a clip. They would be interesting to compare with later tracings. From time to time there were other conversations in Blake's rooms and more rough diagrams. Then the prescription blanks were stuck in a pigeonhole and forgotten. They were to reappear, dramatically, just when Bell began to despair of finding documentary proof of that year's experimenting.

In November, Dr. Blake's father offered Bell the use of a room in his building at Number 77, Kilby Street. Moses G. Farmer's assistant, George A. Hamilton, made a piece of apparatus for some of Bell's Kilby Street experiments and later recalled the enthusiasm kindled by Bell's ardour and 'the

fatherly caution then received not to allow myself to be unduly carried away by some of his theories.' As December came in, Bell spent less time in Mrs. Sanders' basement and more of his free hours in the Kilby Street room and in the loft of Williams' shop at 109, Court Street, where young Tom Watson was now assigned regularly to the making of Bell's apparatus. The Williams establishment at that time occupied the third floor and the attic of the Court Street building. The attic had a partition between its peaked, fly-specked windows. Between these two attic rooms, to the accompaniment of whirring belts and lathes below, Bell was to make most of his tests with the first telephone.

Watson also lived in Salem and commuted to Boston daily as Bell did. Sometimes on Sundays they went for long walks together, Bell thoroughly happy and at home as mentor to the eager youngster who wanted to have a platform voice and to play the piano, but who was careful not to talk about either ambition at Williams' shop. Among many ideas that were startling and new to Watson, Bell unfolded his belief in heavier-than-air flight.

'From my earliest association with Bell,' Watson writes, 'he discussed with me the possibility of making a machine that would fly like a bird. He took every opportunity that presented itself to study birds, living or dead . . . One Sunday we found a dead gull on the beach at Swampscott. Bell spread it out on the sand, measured its wings, estimated its weight, admired its lines and muscle mechanism, and became so absorbed in his examination that, fastidious as he always was, he did not seem to

notice that the specimen had been dead some time. As I was less enthusiastic, I was obliged to keep well to windward of the bird during the discussion.'

They talked about a light steam engine and boiler that Watson had built, and Bell thought that if it could be made larger it might provide power for a flying machine. 'I fancy,' Watson says, 'if Bell had been in easy financial circumstances he might have dropped his telegraph experiments and gone into flying machines at that time.'

(5)

In 1874, Elisha Gray, of Chicago, was also at work upon a device for sending a number of messages simultaneously by telegraph. So were a number of lesser inventors. Gray, who was then in middle life, was chief electrician for the Western Electric Company, at the time the largest manufacturer of electrical apparatus in the United States. The two men were soon to come into conflict over the harmonic telegraph.

Gray had developed his telegraph entirely independently, and yet, in the summer of 1874, Bell knew only that Gray's device was reported to be extraordinarily like his own, and in an agony of distrust he spread his purchases of supplies over the widest possible area of Salem, buying from a single dealer only one ingredient, lest a lurking rival should duplicate his order and in learning the formula should arrive at the same result. Now, no one was permitted to enter his Salem workshop.

(6)

Bell went home to spend that Christmas with his parents. Earlier in 1874, Melville Bell's brother David, co-author of the 'Standard Elocutionist,' had retired from his teaching career in Dublin and had brought his family to Canada. The presence of the family of cousins enlivened Christmas week at Tutelo Heights, and there were a great many charades and three-part songs. Aleck and his father were warmly applauded in 'Lochiel's Warning,' Aleck as the Wizard, declaiming to his parent Lochiel through the fringe of a parlour portière borrowed for the occasion. It was from one of these Dublin cousins that Bernard Shaw had learned the theory of Visible Speech which he was to use in 'Pygmalion.' And one of them, Chichester Bell, was later to share with his cousin Aleck the invention of the graphophone record that made possible the first long stride in the commercial development of Edison's phonograph.

The day after Christmas, Melville Bell's diary noted that the family had dined with David, and the entry added, 'Al's experiments described.' The next entries, so trivial then, were later to become of vast importance.

Sunday, Dec 27 1874: Long talk on multiple teleg & speech trans. Al sanguine.

Tuesday Dec 29 1874: Talking half the night motor and telephone.

Years afterward when Melville Bell was called as a witness in a telephone suit, he was interrogated: 'Did he (Aleck) talk much about it or little?' One

suspects a trace of weariness in the father's reply, 'My chief difficulty in remembering what took place at any one visit arises from the fact that he was constantly talking about the telephone and that he talked of little else.'

Bell got back to Boston for his after-New-Year classes on Monday morning. Young aspirants for platform triumphs were coached as conscientiously as though no certainty of discovery throbbed in the lecturer's teeming brain. Coached to draw themselves up 'as in pride,' to relax 'as in languor,' to advance and retire and to clasp forehead or cheek to the rules of expression prescribed by 'Bell's Standard Elocutionist.' Little George Sanders paid Bell delighted tributes in lessons eagerly resumed, and since there was no way to pursue his experiments during his crowded day, Bell began to stay later and later at Williams' shop with the faithful Watson, whose labours were often thus spread over an eighteen-hour day, and whose sleeping was become as erratic as Bell's own.

Bell, being busy during the day [Watson tells], would often ask me to stay in Boston with him in the evening to help him test his apparatus when I had finished some of it.

One evening when I had been working with him, trying some new feature in the discouraging harmonic telegraph, he said to me, perhaps to cheer me up a little, 'Watson, I've another idea, I haven't told you about, that I think will surprise you.' I listened somewhat inattentively . . . but when he went on to say in his usual convincing way that he had had an idea in his head for more than a year by which he was sure he would soon be able to *talk by telegraph*, his startling assertion banished my tired feeling and I don't remember that it ever came back. Bell had a remarkable power for clear and terse explanation. The

words he used in giving me the essence of his great idea have remained in my mind ever since.

'Watson,' said he, 'if I can get a mechanism which will make a current of electricity vary in its intensity, as the air varies in density when a sound is passing through it, I can telegraph any sound, even the sound of speech.'

The open gas-jets flickered, sending fitful shadows up and down the dusty attic walls, while Bell explained his theory to the tired but spellbound Watson. Then he sketched an apparatus which he thought would accomplish it. They talked about what it would probably cost. But they didn't make it. It would have been too expensive, and, says Watson, 'the chances of its working were too uncertain to impress his financial backers . . . who were insisting that the wisest thing for Bell to do was to perfect the harmonic telegraph; then he would have money and leisure enough to build air castles like the telephone.'

CHAPTER VIII

(1)

THE winter of 1874–75 wore on. Bell rushed from his own class-rooms to his lecture engagements at Boston University, then to Williams' shop to work until the last train left for Salem, and, utterly fatigued, he and Watson stumbled into the nearest seat. There were mornings when little George Sanders had no lessons because Bell was still in bed.

In February the multiple telegraph was close enough to success to apply for a patent, and, worn out, Bell left for Washington to draft the specifications and make his application. So that he need not have hotel expenses, Mr. Hubbard tactfully suggested that he should stay at his lodgings in Washington. Sanders, so the story goes, advanced the money for his ticket.

It was during this visit to Washington, concerned though it was with the multiple telegraph, that Bell met the encouragement of Joseph Henry which bore so importantly on the invention of the telephone.

Back in Boston on March 5, he wrote a long letter to his parents. It was written on the train from Salem to Boston and is full of enthusiastic detail:

DEAR PAPA AND MAMMA:

Please let me hear from you. Let me hear all the news. I have been working day and night in Washington, so that I have been unable to see the sights as yet. Every-

thing looks most promising. One of the first things I did on reaching Washington was to set up my apparatus so as to make four stations, A. B. C. D.

A B C D

My wish was to illustrate that a message could be sent from B to C at the same time that a message passed from A to D.

I had four cells of a battery, but no acids. In order to have plenty of battery power, that the thing might work well enough, I wished six cells and a mixture of Bi-chromate of potash with some acid (I forget what).

There was only one electrician in town, and I went to him for everything, unfortunately giving my name.

He sent me down two cells of Lockwood's battery, and I was surprised that the young man who brought them came right into the parlour and stared about, to see what kind of instruments I had got.

Still further was I surprised to find that the two cells he brought *would not work*.

The young man came back with the bi-chromate solution for the other cells, but I had my suspicions aroused and did not use the solution.

To add to my distress, Mr. Hubbard informed me that Mr. Orton (the president of the Western Union Telegraph Company) would be round in half an hour to see my instruments.

'The Western Union' is probably the largest corporate body that has ever existed. It controls more miles of telegraph wire than *there are in the whole of Europe!* It was, therefore, important to have my instruments in good shape. I did my best by getting nitric acid and sulphuric acid to get the cells I had in working order. I sawed a large carbon in two, borrowed a couple of slop basins and had the whole in working order just *half-a-minute* before Mr. Orton made his appearance. The instruments, by good luck, never worked better. Mr. Orton was very much interested, and said he would like to see me again, but had to go to New York that night.

Two days afterwards, I was in the Capitol seeing the Senate, when a gentleman came up and tapped me on the shoulder. It was Mr. Orton. He told me that the Western Union would be glad to give me every facility in perfecting my instruments, and he gave me a hearty invitation to take my apparatus to New York, and I should have the assistance of their best electricians.

They have a special experimental room, and have at instant command thousands of cells of battery, and thousands of miles of *real* wire to test with.

Mr. Orton said, further, that he wished me distinctly to understand that the Western Union had no interest in Mr. Gray or his invention.

This is very encouraging. Mr. Orton had *previously* seen Gray's apparatus, and yet came forward to take up mine.

It is a delightfully characteristic letter. It is Bell at his buoyant best, with its confidence and its enthusiastic underlinings. And it is not without its unconscious humour. The open-mouthed youth from the one electrician in Washington, boldly staring about, becomes to Bell's excited mind the emissary of a rival inventor. The cells wouldn't work — well, he wasn't such a simple fellow as they thought, he wouldn't use the bi-chromate solution. Commotion ensued in the Hubbard *ménage*. Bell stormed through the house, 'borrowing' slop basins from startled housemaids, improvising makeshift batteries, having all in readiness just *half a minute* before the arrival of the great Mr. Orton, whose company was the largest corporate body that had ever existed, with so incredibly many miles of *real* telegraph wire. There is a longing note here. It was only by courtesy of local managers of these real wires that Bell was able to make his tests and,

later, to send his early messages with the telephone. He emphasizes this incredible good fortune. 'Thousands of miles of *real* wire to test with.' Think of it!

(2)

A few days before this letter to his father and mother, Bell had concluded his formal agreement with his backers, in which Sanders and Hubbard agreed to contribute each one half of all expenses incurred in perfecting his telegraphic inventions and in taking out patents and defending interferences to the patents, all profits to be shared equally by Bell, Sanders, and Hubbard. Bell agreed also to assign to this triumvirate, of which he was one, 'all his right, title and interest in and to any further improvements he may make in perfecting said inventions or improvements.'

But despite this, Bell was carrying a load impossibly heavy. He said somewhere long afterward that neither Mr. Hubbard nor Mr. Sanders realized its weight.

They paid for the purchase of experimental supplies and the work done at Williams' shop but (excepting for the teaching fee from Sanders) they paid him nothing for his time. Apparently it did not occur to Bell to suggest that they should. For his living expenses he depended on his teaching, and in his preoccupation with electricity his classes had steadily dwindled.

It was inevitable that neither of his backers should realize his anxieties, for neither had ever felt the actual stress of need, and without that acute ex-

perience neither could appreciate the straits to which his poverty was reducing Bell.

The buoyant confidence of his earlier letter is gone by the time he returned from his first week-end visit to New York in response to Mr. Orton's invitation.

The experiments for the Western Union had gone well, but many adjustments and improvements had still to be made; and, to add to his troubles, his application for a patent was declared in interference with an application of Elisha Gray's. He wrote:

292 Essex Street, Salem
March 18, 1875

Dear Papa and Mamma:

I have just returned from my trip to New York thoroughly worn out. Found your letters of the 14th awaiting me. I am now beginning to realize the cares and anxieties of being an inventor. In order to complete the apparatus as thoroughly as possible, I have decided to give up all professional work for some weeks. I have put off all classes until the 12th of April. Flesh and blood could not stand much longer such a strain as I have had upon me. Professional work is all in confusion, and the only way is to cut the Gordian knot and throw up everything until the end is achieved. I long to write full accounts to you and I have delayed writing in order to give a connected narrative of the whole. You seem to think that my anxieties are over, when in truth they are really only beginning. . . .

He was too sunk to underline anything. Among the cares and anxieties of being an inventor was the necessity of taking out foreign patents — and paying for them. Would his father and mother help him in this? Only in an extremity would Bell ask a

loan from his parents. That he asked it then is the final proof of his need. Would they also hunt over his old letters for anything bearing on the telegraph and forward it at once for evidence. While the foreign applications were being made, he would write to old friends in Edinburgh, the Herdmans, offering them a share if they would underwrite any interferences that might arise in connection with the foreign patents. Should the Herdmans decline, which, said Bell, 'I think unlikely,' he should 'of course relinquish a foreign contest.'

Bell does not seem to have resumed his teaching that April 12, or later. Afterward he said that he did not remember whether he opened the classes then or not, but his teaching was soon so disorganized 'as to fail me altogether, until I was practically dependent for support upon the instruction of my little pupil in Salem.'

It was a harassed young man who now gave most of his night and all of his day to perfecting the working of the multiple telegraph.

Satisfactory as its effects were at times, the behaviour of the multiple telegraph was decidedly uneven. 'By spring,' Watson says, 'my faith in the harmonic telegraph had vanished, and at last, after months of work on it, Bell's magnificent courage began to flag.' Watson knew that Bell was losing his enthusiasm because now he worked in silence instead of spurring on with his accustomed battle-cry, 'Watson, we are on the verge of a great discovery!'

Sometime in April of 1875, Elisha Gray's attorney, Mr. Hayes, had proposed that Bell should

merge his work with Gray's. He made the suggestion through Mr. Hubbard. Bell, in response to Mr. Hubbard's enquiry, consented to show Mr. Hayes some of his apparatus in operation, but, he wrote flatly, 'I don't propose to have Mr. Hayes enter my sanctum sanctorum.' No, indeed. He would run a wire downstairs from his study 'into one of the parlors.' Patient Mrs. Sanders!

(3)

Bell strung another wire that spring from his study window to the next door music rooms of 'my friend Don Manuel Fenollosa.' He wanted to try the effect of passing an intermittent current of electricity through the strings of a piano: to produce by electricity the effect Wheatstone had produced by the mechanical vibration of a deal rod with the first 'telephone,' or enchanted lyre: the same effect that Bell produced by sympathetic vibration when he depressed the pedal and sang single notes into the piano. In short, an experiment in variable resistance which was defeated then because the strings of Mr. Fenollosa's pianos were metallically connected in some way.

And with everything else, Bell worked hard at his autograph telegraph, a device by which he expected to copy handwriting, and which promised to be exactly ten times more rapid than any other, as well, he said, 'as the cheapest.'

But with his patent allowed on the multiple telegraph and the invention announced to the world, the world's greatest corporate body lagged in its offers and no such fortune as seven hundred and

fifty thousand dollars, nor even a fraction of that great sum, relieved the pressing difficulties of the penniless young inventor.

And now, Bell says, 'I began to be in real want.'

At last he went to Professor Lewis B. Monroe, head of the School of Oratory of Boston University, and told him of his plight. Monroe, to Bell's lasting gratitude, advanced him the fees for the next year's lectures. 'Without this aid,' said Bell, 'I would not have been able to get along at all.'

(4)

Watson has pointed out the good fortune that lay disguised in the failure of the multiple telegraph to realize its full potentialities. Had it been a complete success, Bell might never have persisted to its greater sequel.

On May 24, he wrote:

SALEM, MASS., *May* 24, 1875

DEAR PAPA AND MAMMA:

I am so immersed in telegraphy and science that I find it impossible to write freely about anything else, but I feel that at the present time you can scarcely be inclined to listen to anything I have to say on such subjects.

Since I gave up professional work and devoted myself exclusively to telegraphy, I have been steadily gaining health and strength, and am now in a fit state to encounter Mr. Gray or any one else. The patents that have been granted to me without opposition are:

1st. The principle of converting a vibratory motion into a permanent make or break of a local circuit.

2nd. The special form of 'vibratory circuit breaker put in illustration.

3rd. The autograph telegraph.

The autograph arrangement is rapidly approaching

completion. Already I can copy handwriting *quite legibly*, though not yet neatly. The rate of transmission by means of my instrument will be exactly ten times more rapid than 'Bakewell's Autograph Telegraph,' in which the rate is 300 letters per minute. When 3000 letters per minute can be sent, my telegraph will be the most *rapid* as well as the *cheapest*.

Every moment of my time is devoted to study of electricity and to experiments. The subject broadens. I think that the transmission of the human voice is much more nearly at hand than I had supposed. However, this is kept in the background just now, as every effort is to be made to complete the autograph arrangement, so as to have it used on some line. . . .

Truly, the more I study electricity and magnetism the more I feel the truth of Hamlet's saying, 'There are more things,' etc.

I fear that this telegraphic business may force me to remain the greater portion of the summer here, but I cannot tell yet, so many details have to be worked out. My inexperience in such matters is a great drawback. However, Morse conquered his electrical difficulties although he was only a painter, and I don't intend to give in either till all is completed.

With dear love
Yr affectionate son

ALECK

It was a prophetic letter. The transmission of the human voice was not only more nearly at hand than he had supposed; it was only a week away.

Through the early heat of that May and into June of 1875, Bell and Watson had toiled in the loft of the Williams shop. And then, on the second day of June, by accident, and for the fraction of a second, the clue to electric speech flashed into the noise and heat of that dusty Boston attic. And

Bell saw it. It was the 'means,' for which he had waited a year, to accomplish his conception of 1874. It was an effect that must have been produced unnumbered times in the history of telegraphy: produced accidentally, as it was produced then. But only an ear as trained in sound as Bell's, only a brain as alert to its meaning as his could have caught that split-second flash and recognized it for what it was. 'Moses G. Farmer told me with tears in his eyes,' said Watson, 'that when he first read a description of Bell's telephone he couldn't sleep for a week, he was so mad with himself for not discovering the thing years before. "Watson," said he, "that thing has flaunted itself in my very face a dozen times within the last ten years, and every time I was too blind to see it. But if Bell had known anything about electricity, he would never have invented the telephone."'

Watson, who was there that June afternoon, is still living. He has told the circumstances. Bell's harmonic telegraph operated by means of signals of different musical pitch. The receiving apparatus had to be accurately tuned to the transmitter. When the pitch of the receiving springs varied — even ever so slightly — from those of the transmitting instrument, the signals were thrown into hopeless confusion, probably the reason for its failure to attract the Western Union Telegraph Company. Since Watson's ear was unequal to the delicate adjustment, Bell was accustomed to tune the receiving springs himself.

On that June afternoon he was pressing the receiving springs to his ear as usual. Sixty feet away,

in the other attic room, Watson plucked the corresponding spring in the transmitting apparatus. Bell tuned one of them after another, listening intently while he manipulated the tuning screw, until suddenly one of Watson's springs stopped vibrating. He touched it again to start it, but still it stuck. Watson kept on plucking it. Suddenly he heard a great shout from Bell. He strode into the room, like Archimedes from the bath. 'What did you do then?' he shouted. 'Don't change anything! Let me see!'

'I showed him,' says Watson, 'it was very simple. The make-and-break points of the transmitter spring I was trying to start had become welded together, so that when I snapped the spring the circuit had remained unbroken while that strip of magnetized steel, by its vibration over the pole of the magnet, was generating that marvellous conception of Bell's — a current of electricity that varied in intensity precisely as the air was varying in density within hearing distance of that spring.' The current thus produced passed through the connecting wire to a receiver fortunately constructed to transform it into a faint replica of the sound, and the man who heard the sound knew what it was.

'The shout I heard,' says Watson, 'and his excited rush into my room were the result of that recognition. The speaking telephone was born at that moment. Bell knew perfectly well that the mechanism that could transmit all the complex vibrations of one sound could do the same for any sound, even that of speech.'

For several hours they verified that marvellous

accident, repeating the effect with every tuned spring they had.

'Before we parted that night,' Watson says, 'Bell gave me directions for making the first electric speaking telephone. I was to mount a small drumhead of gold-beater's skin over one of the receivers, join the centre of the drumhead to the free end of the receiver spring and arrange a mouthpiece over the drumhead to talk into.'

Too excited to sleep, Bell wrote to Mr. Hubbard the same night: 'I have accidentally made a discovery of the very greatest importance...' He would call upon him the next evening to tell him about it. Alas, that no record survives of that interview in the Brattle Street library.

Watson rushed the apparatus to completion, the first telephone, transmitter and receiver in one, with its stretched membrane of gold-beater's skin. Crude as it was, it operated just as the telephone operates to-day, on what Watson calls 'a sound-shaped current' of electricity. It is the only means ever discovered for sending speech over a wire. The instrument was ready the next day.

But the attic rooms were too near together for any adequate test. Even the normal voice could be heard through the air, and they of course expected to have to shout by telephone.

Watson, resourceful, indefatigable Watson, therefore strung a wire down two flights of stairs to the main floor of the Williams shop, ending it near his own work bench. It was the first telephone wire. Then when the shop was closed, Watson hid the telephone in his clothes locker and went to supper.

Bell appeared soon after he returned. The lathes and belts were still. They had the building to themselves. So they began, Bell at one instrument in the loft, Watson with its duplicate below.

Bell shouted and sang, concentrating the vibrations on that bit of membrane with his sure knowledge of voice mechanism. Then he put the apparatus up to his ear to listen for Watson's answering effort.

There wasn't the slightest sound.

Then came a fearful clatter on the stairs, and Watson burst into the room. 'I could hear you!' he yelled. 'I could hear your voice! I could almost make out what you said!'

They changed places and tried again. But Bell could hear nothing. Bell, of course, had an unusual speaking voice, and used it with the skill of training and long practice. Watson, on the other hand, had very acute hearing. All through the early tests with the telephone, Watson could hear Bell better than Bell could hear him.

But that night Watson's wild excitement was quite proof enough for Bell, and he set out to devise one variation of the instrument after another, and — through June — as fast as he sketched them, Watson put them together.

(5)

Bell wrote further enthusiastic letters to Mr. Hubbard, but Mr. Hubbard seems to have been unimpressed by the world-moving and world-shaking possibilities of this new product of Mr. Bell's too prolific brain. He wanted him to get on with the

multiple telegraph and the autograph telegraph. Hubbard admitted later: 'During the summer and autumn of 1875, Mr. Bell's mind seemed to me to be occupied with the electric transmission of speech a great deal more than was to my pecuniary advantage, as I did not then believe the transmission of speech could ever be made commercially valuable and I at several times remonstrated with him for spending so much time upon the subject.'

There seems to have been an important difference in the attitudes of Sanders and Hubbard. While Hubbard's faith was in the multiple telegraph, Sanders' unbounded faith was in Bell.

It is always easy to be wise after the event, and Hubbard's attitude was not more unsympathetic than that of any other backer Bell might have had in the seventies, when many of the best minds in electricity declared the speaking telephone to be an impossibility. He did Bell an invaluable service in advising the constant letters on his work which were to be of such enormous value to him later, and in his services to its later commercial introduction redeemed his first apathy. But it is nevertheless impossible to review Bell's struggle of 1875–76 without realizing that by that opposition his telephone was a year later than it might have been, first though it was.

Up to a point, with his unfailing histrionic instinct, Bell dramatized his difficulties. He compared himself to Morse, who conquered electricity 'although he was only a painter.' 'And I don't intend to give in either,' wrote Bell with a flourish, 'until all is completed.' But dramatize it as he might,

sharp reality began to wear through the brave stuff of his fancy: the reality of unpaid rent; of pitiful little personal loans that left stinging marks in pride untouched by frayed cuffs and shabby coats; the realization that to his world he was not at all the romantic figure of penniless genius of his mind's eye, but only a tiresome young man who neglected profitable inventions to pursue chimerical ideas.

Bell's spirit might better have sustained this ordeal if he had not been so desperately in love. Watson says, 'I never saw a man so much in love as Bell.' There was never a time in Bell's life when he wanted recognition as much as he wanted it then. Once, when he was an old man and some new and superfluous honour was offered to him, Bell said with rare bitterness, 'Why do they offer that to me now? What good is it to me now? It would have meant everything to me when I was a young man!'

At twenty-eight he knew well enough that even his friends were a little impatient, and a little uneasy, about his insistence upon the idea of talking by electricity; that his family did not approve of his neglect of his professional work, and that persons less well disposed openly tapped their foreheads, and grinned. These things he could bear. But in the summer of '75 Mr. Hubbard seems to have told Bell flatly that, unless he gave up this nonsense of the telephone and got to work to perfect the multiple telegraph, he could not marry his daughter.

Years later, when Bell gave his evidence in a patent suit, he was cross-examined on that summer, and under the court's abrupt disregard of his reti-

cences, admitted that a climax in his love affair had completely disorganized his work for three months. 'After the beginning of July, 1875, my mind was much worried and disturbed by difficulties of a personal nature between myself and Mr. Hubbard's family. I do not care to go into the details of these difficulties, but may say that they were not entirely removed until the 25th of November when I became engaged to marry Mr. Hubbard's daughter.'

He continued to make formal reports to Mr. Hubbard of some experiments through the month of August — that phenomenal August of 1875 when it rained every day; but he was wretched and unstrung, left Salem infrequently, and at last in early September he fell really ill and had to go home to Brantford. But he did not give up the telephone.

CHAPTER IX

(I)

In the golden September weather Bell lay out under the white-boled birch trees above the river-bank at Tutelo Heights, watching the wing-spread of the birds soaring overhead, the phrasing of the new patent specifications running in his tired mind. Finally he began the written draft. He wrote on foolscap sheets, the eight-by-thirteen, glossy, ruled 'examination paper' so familiar to all Canadian school-children. Seven of the historic sheets survive.

As some of his old vigour returned, he began to ride, and presently to make new plans. He wanted a new backer. If he could finance himself over a further short period, Bell knew that he could perfect the speaking telephone, but he felt under heavy obligations to Thomas Sanders, and now he could not ask Mr. Hubbard for any assistance, 'and did not even care that Mr. Hubbard should know of my pecuniary condition.' Naturally!

If he went back to his teaching, Bell knew that he could support himself, but by this time he had learned that even his fierce proud spirit could not successfully spur the flesh to more than one thing at a time. And he would not give up work on the telephone. The alternative was to get some one to finance him over the gap. He thought of his father's neighbour, the Honourable George Brown, whose triumphant voice now lauded the policies of Sir Alexander Mackenzie's Liberal administration, as it

had denounced those of the late Government, and whose three hundred prize shorthorns still throve in the lush meadows of Bow Park.

In Canada, the Conservative Premier had lately resigned under the pressure of the 'Pacific scandal' (involving contracts for the new Canadian Pacific Railway), and with his party in power the Honourable George Brown was a person of considerable influence. He was just back from a diplomatic mission to Washington, where, however, the United States Senate had spurned his proffered renewal of the reciprocity agreement.

Bell went to Brown originally with the idea of asking for a letter of introduction to the Canadian financier, Sir Hugh Allan, owner of the Allan Steamship Line. But there was little love lost between Brown and Allan that year. Sir Hugh's contributions to the campaign funds of the Conservative Party had precipitated the Pacific scandal, brought Brown's party back into power and thrown Allan's group out of valuable railway contracts. Bell could not have chosen a worse approach to Sir Hugh. However, when he called on the Honourable George Brown in September, Bell found him so interested in the new invention that he offered to go into it himself. With his brother, Mr. Gordon Brown, he agreed to lend Bell the money he needed. Like every destitute inventor, Bell said, afterward, he was ready to give them any share they wanted. He was too hard-pressed to make terms. Their agreement was to be based on British and other foreign patents. It was arranged that, as soon as the patent specifications were ready, Bell should send a copy to Messrs.

Brown to be filed in England, and that no copy should be filed in the United States Patent Office until this should be accomplished. Otherwise it seemed that, by the English patent law, the patents would be invalidated in that country.

This promising arrangement was concluded verbally late in September. Bell departed promptly for Boston to get to work on the patent specifications, leaving the formal agreement to be sent on when duly drawn up by the brothers Brown. The immediate loan was intended, in part, to repay the fees advanced by Professor Monroe, so that Bell need not be hampered by lecture engagements. The specifications were soon under way, and, said Bell, 'I awaited with feverish anxiety the arrival of the expected agreement in black and white.' It did not come.

It was now October, and unless he could refund the fees paid in advance, the lectures at Boston University would have to be delivered. 'I need hardly say,' said Bell with the restraint of after years, 'that the non-arrival of the expected communication from Canada placed me in a very serious predicament.'

It did, indeed. It put him in a very tight place. And, moreover, the communication never did come. There was nothing to do but to go back to teaching.

(2)

In schools for the deaf there was by this time a great deal of interest in Bell's speech-teaching methods. He worked out a plan for recruiting a class of teachers from various normal schools. He planned to instruct these teachers in his technique, and then,

by handing over to them his own private pupils, keep his professional work together, so that if all other sources of income failed him he could go back to teaching. He had no difficulty in recruiting the normal class, but after his long neglect of teaching he found that he had no pupils to hand over to it. To Bell this was a mere detail. He organized a free class of deaf adults to give his normal teachers the necessary practice, and threw himself into the work with such energy that private pupils began to pour in. His teaching was as inspired as ever.

During this episode Bell submitted terms for two months' instruction in Visible Speech at the Pennsylvania Institution for the Deaf and Dumb. Rummaging for a clean scrap of paper, and finding none, he scribbled a rough draft of his letter in ink over one of the pencilled foolscap drafts of his patent specifications made at Tutelo Heights. It was a fortunate bit of carelessness. The terms were unsatisfactory to the Pennsylvania school and Bell stayed in Boston. But long afterward, when he was required to prove the date of his original specifications, the scribbled draft of his letter, combined with the files of the School, dated the foolscap draft of his patent beyond argument.

(3)

October passed and then November, and still there was no word from George Brown. Hubbard was a lawyer and both he and Sanders were shrewd business men, and even if they were not yet aware of the value of the telephone they knew that it was new and ought to be patented. One never could

tell. Something might come of it. But Bell would not risk the loss of his English and other foreign patents by applying first in the United States. He was not to be moved from his decision. 'Mr. Hubbard,' he said, 'was especially anxious about the matter.' Bell would do nothing until after his Christmas holiday, when he would have another opportunity of seeing Mr. Brown. He was just as determined, just as inflexible, when he was wrong as when he was right. This time he was wrong.

(4)

Bell now found that, in another dilemma, he had an unexpected ally in Mrs. Hubbard. In the intervening months she had furthered the suit of the unhappy and infatuated young man, the 'difficulties' had been smoothed over, and it was decided that, if parental consent could not yet be given to their marriage, at least the young people might become formally engaged.

The 25th of November was Mabel Hubbard's eighteenth birthday. The agitated Bell turned up his coat-collar and took a horse-car out to Brattle Street. He was in a tumult of apprehension all the way. His stage-fright was acute by the time he rang the Hubbard doorbell, half-minded to make some excuse to the servant and rush away — and then Mabel Hubbard herself opened the door. He proposed to her that November afternoon and she accepted him.

(5)

The events of the Christmas vacation of 1875 and

the month of January, 1876, brought the Brown episode to a climax. Tense with anxiety, after repeated delays, Bell finally went on to Toronto from Brantford on the 28th of December. He offered the Honourable George Brown a half-interest in all patents that the latter would take out for him abroad. In return Bell asked his financial aid while perfecting his inventions and preparing patent specifications.

Mr. Brown took the night to think it over. Back at the Queen Hotel, Bell made drawings of his apparatus, paced his bedroom floor rehearsing the arguments he would use next day, and wrote a letter which has survived. He thought 'it is pretty evident that George Brown intends taking up telegraphy abroad for me; still I don't allow myself to indulge in too many hopes, lest I should be disappointed.'

The next morning the agreement was concluded. The Honourable George Brown and his brother were each to pay Bell twenty-five dollars a month for not longer than six months in return for a half-interest in all the Bell patents outside of the United States! Their letter of the same date confirmed this offer:

TORONTO, *29th Dec.*, 1875

Professor A. G. Bell,
Salem, Mass.

DEAR SIR:

We hereby agree to pay you twenty-five dollars in United States currency each of us per month while you are perfecting your inventions in telegraphy and preparing the necessary specifications for taking out patents under our agreement of this date; said monthly payments

to cease when the patents are obtained, and in no case to extend beyond six months.

Yours truly

GEORGE BROWN
J. G. BROWN

With the literal honesty so characteristic of him, Bell had explained that he did not now need the loan for which he had asked in September, since he was no longer in debt to Professor Monroe, but 'asked them, however, to pay the expenses of special rooms where I could keep my electrical apparatus in a private manner, as I was quite troubled by rumours that had reached me that strangers were visiting Mr. Williams' workshop and examining my apparatus with curious eyes.'

'During the year 1875, and up to the time this letter was written,' Bell explained in speaking of a letter to Mr. Hubbard of August 14, 1875, 'I had allowed myself to entertain ungenerous thoughts of Mr. Gray and believed him capable of spying upon me. Indeed, this idea subsequently led me to remove my apparatus entirely from Mr. Williams' shop to private rooms at Exeter Place.'

George Brown was going to England almost immediately, and in consideration of his willingness to provide this privacy, Bell renewed his promise to delay application for an American patent until application should be filed abroad. On the strength of the Brown agreement, Bell returned to Boston, found two attic rooms on Exeter Place, and rented them for four dollars a week. He moved in at once.

Despite the written proof of the Brown good will and the Exeter Place rental, Mr. Hubbard was

exasperated upon learning that there was to be further delay in the filing of the American patent specifications. When Mr. Brown's sailing was delayed from one ship to the next, Mr. Hubbard at last insisted that Bell should at least have a copy of his specifications sworn to and should send it to his attorneys in Washington, ready to file the moment word should be received from Mr. Brown.

Hubbard spoke with the authority of a prospective father-in-law. Bell capitulated. January was now in its second week and still Mr. Brown had not sailed. But if Bell was beginning to have his own doubts about the wisdom of waiting for the English patents, he had given his word and he stuck to it.

And, characteristically, he seized the delay to amend the phraseology of his specifications. Bell rarely wrote anything without first making a rough draft, and all his life he painstakingly revised and rewrote everything intended for publication. Years later, when Mabel Hubbard was Mrs. Bell and was helping to bring order out of his chaos of papers, she found rough drafts of some of his most 'spontaneous' love letters! He had a hereditary passion for exact terminology, and now the validity of his patent might depend on the choice of 'undulating' rather than 'vibrating' in describing that marvellous, simple current that carried the human voice along a wire. He had gone over the wording of the patent again and again, and he was still dissatisfied with it. There was, as he expressed it, a 'hole in it somewhere.' When Mr. Hubbard named a date upon which he must have the document ready to send to Washington, Bell was beside himself. He would

have to sit up all night and find out what was the matter with it.

Mabel Hubbard had begun to take care of Bell as soon as they became engaged. He came to her for advice. He was going to give up all his erratic ways and go to bed early — at least not later than midnight. His precious patent specifications were now kept in Mabel Hubbard's neat desk, and Bell went out to Cambridge to spend the night and to work over the patent on that last evening. At midnight Mabel leaned over the bannisters and called, 'Aleck, you must go to bed now!' He bounded up the stairs to tell her that he had *nearly* found the hole. If she would let him off *just this once*, he would *never* do it again. The italics are Bell's. Had Mabel Hubbard said 'No,' it would have been quite in character for the infatuated Bell to have gone to bed at her command and felt the patent well lost. Fortunately, she relented. Soon the house was still, and Bell — whose mind was always clearest at night — suddenly saw what the trouble was.

He had forgotten to put in any clause covering the experiments in variable resistance which he had made in the winter of 1874–75. 'It did not take me twenty minutes,' he said, 'after I found where the point was, to remedy it, and put into the patent what is now known as the variable resistance clause, and that clause saved the patent. Nearly all the litigation that took place afterward was really on that clause. That night,' said Bell with his unfailing appreciation for good theatre, 'a girl held in her hand the whole future of the telephone!'

So he copied the specification again in his neat,

tight hand, and it was sent down to Messrs. Pollok and Bailey in Washington.

On the 18th of January, Bell wrote to Mabel Hubbard: 'I received a nice letter from your father this morning, in which he says how well pleased he is with the new specification, and that it promises to be of great value if I *prosecute my researches diligently;* if not, others may supplant me.'

Mr. Hubbard had written, 'I have been over your specification with Mr. Pollok. He is very much pleased with it and says he does not think it will require any alteration.'

But the specification was not to be filed until action had been taken to secure the English patent. And another week went by, and still the Honourable George Brown did not sail.

Mr. Brown finally left New York on January 25. Bell was there to see him off, and at Bell's request Mr. Hubbard and his patent attorney came on to meet Mr. Brown before he embarked. Brown promised to cable the moment the necessary application could be made by his London solicitors.

They waited for a fortnight. This was ample time for a passage to England in the S.S. Dakota in 1876. Then a third week passed, and there was no cablegram from Mr. Brown. Hubbard determined to wait no longer. And he hazarded no scene with that stiff-necked young Scotsman, his prospective son-in-law. Without saying anything to Bell, he communicated with the Washington attorneys and they filed the patent specification on the 14th day of February, 1876.

A few hours later on that day, Elisha Gray filed

a caveat in the Patent Office, covering his ideas in the transmission of speech by electricity. The legend of Gray's simultaneous invention of the telephone was later to become so widespread that in the course of years this caveat became popularly identified with an application for a patent, which of course it was not.

A caveat, as Gray later expressed it himself, is a 'mere description of an idea that has never been reduced to practice,' and not, as a specification is, the description of a completed invention.

But for the negligence of Brown, Bell's application would have been filed in the previous October, yet the coincidence of the filing of Bell's patent specification and Gray's caveat on the same day, played an important part in the protracted telephone litigation of after years.

Bell never forgot, and never forgave the behaviour of Brown. It rankled when he was threescore and ten and when most old injustices had been dismissed if not forgotten. It later appeared that the farther Brown got from Bell's convincing presence, the crankier the notion seemed. By the time he got to London, he was afraid that he would be laughed at if he spoke of it at all, so he left the specifications in the bottom of his trunk throughout his stay! Perhaps they had been put there with some premonition of this decision. One payment of the promised monthly remittance was made about the end of January, then it lapsed and was never revived.

Inexcusable as Brown's behaviour was, and damaging as the whole connection had been to Bell, Brown was quite right in supposing that among

financiers he would be ridiculed for any association with the telephone at that time. London dismissed it a little later as 'the latest American humbug.' Four years after, Brown was assassinated in his newspaper office by a discharged printer, so the unfortunate gentleman did not live to repent of the error by which his heirs, as well as Bell, lost a great fortune, and which changed the whole history of the telephone in England.

(6)

Watson had fitted up the back room of Bell's Exeter Place quarters as a laboratory, running a wire down a little hallway to connect it with the room fronting on the street in which Bell slept. 'No. 5, Exeter Place, soon became as familiar to me as Williams' shop,' says Watson, 'for whenever I finished for Bell the construction of some modification of the telephone, I carried it to the new laboratory, to spend the night testing it and discussing further improvements, getting a few hours' sleep in Bell's bed toward morning.' One may assume that the third occupant of that attic floor got only slightly more sleep than Watson and Bell. Apparently the rule about Bell's midnight retiring was now relaxed. Later, Bell told Watson that his fiancée was painting his portrait, and would soon have it sent to him to hang in his rooms. When it came it was an oil painting of a large, lifelike owl. This jest on Bell's late hours hung in the laboratory until he was married and abandoned Exeter Place.

Late in February, Bell learned that Mr. Hubbard had taken matters into his own hands and that his

application for an American patent had been filed. Despite the financial returns which came to Bell from this timely interference, he never quite forgave his father-in-law for this act, by which — in effect — Bell had broken his word. He was summoned to Washington to see his attorneys, and on his twenty-ninth birthday, March 3, 1876, the application was allowed. On the 7th, the patent was granted. He had returned to Boston between these dates, and — 'I remember Bell's joy,' writes Watson, 'when he brought me the news that his patent had been allowed almost as he had written it.' The patient midnight 'tinkerings' with its phraseology were to be amply rewarded. So fully and clearly did Bell's description cover the whole conception of his great principle, as well as the means of utilizing it, that its wording was to stand every test of later litigation.

By this time the telephone had got to the stage of the battery transmitter. In the first magneto-electric instrument the voice was the sole source of power. Now Bell had devised an instrument based on his experiments of 1874–75 in which the voice varied the resistance of a circuit through a galvanic battery. Watson had finished a new transmitter 'in which a wire, attached to a diaphragm touched acidulated water contained in a metal cup, both included in a circuit through the battery and the receiving telephone. The depth of the wire in the acid and consequently the resistance of the circuit was varied as the voice made the diaphragm vibrate, which made the galvanic current undulate in speech form.' Watson brought the new transmitter to Exeter Place on the evening of March 10, 'intend-

ing,' he said, 'to spend the night with Bell testing it.'

Neither of them had any idea that they were about to use the best transmitter yet devised. They diluted the sulphuric acid for its cup, connected it to the battery and to the wire running between the rooms, and then Watson went into Bell's bedroom and stood by the bureau with his ear to the receiving telephone.

Almost at once Bell's imperative voice seemed to leap from the diaphragm, 'Watson, come here, I want you!'

It was a shout for help.

Watson dashed down the hall into the laboratory. Bell had upset the acid of a battery over his clothes. In his delight over Watson's sudden appearance, Bell forgot all about the spreading acid stains on his trousers and flew to the other end of the wire, to hear Watson's voice now coming clearly through.

They exchanged places again and again. Afterward, that night, Watson jotted down some of their sentences in his little pocket diary. Apparently topical exchanges did not occur to them. They declaimed to the instrument. When they ran out of sentiments, they counted, one, two, three, four. 'God save the Queen,' said Bell.

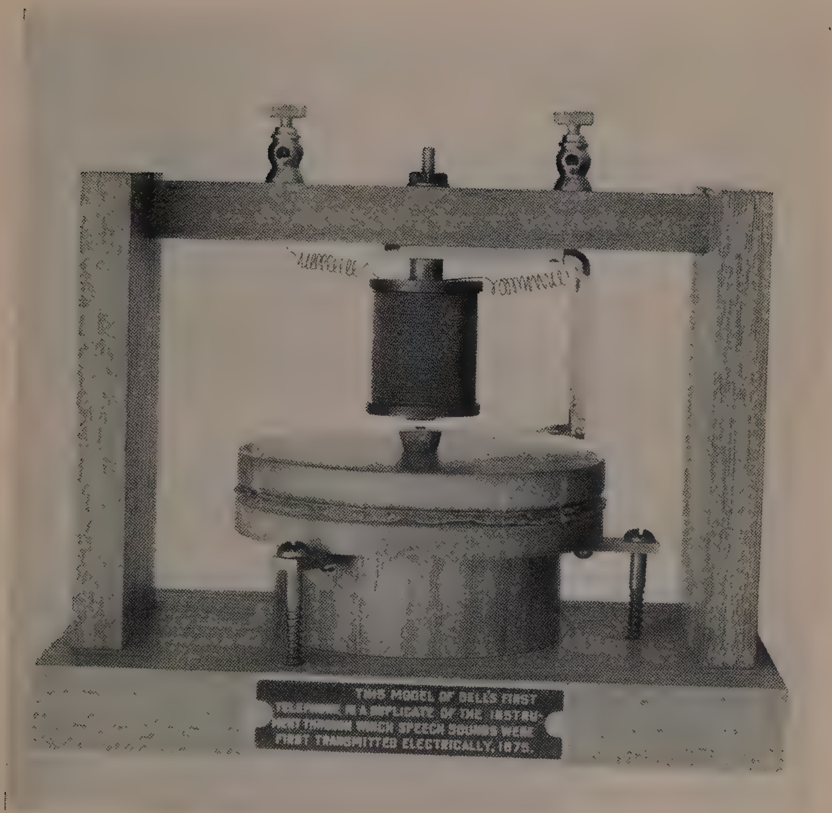
CHAPTER X

(1)

Eighteen seventy-six was the Centennial year of the Republic. As her hundredth birthday neared, the young Nation, so lately delivered from the perils of civil war, had pulled herself together, looked about on the progress of her first century and invited the whole world to Philadelphia to a great exhibition which was to eclipse the fairs of twenty years past in London and Paris and Vienna.

The Centennial Exhibition was later dimmed in American memories by the World's Fair at Chicago, but the Centennial was the Republic's first great enterprise of the kind and it gave expression and unity to a national sentiment which the country sorely needed in '76. Administration scandals, the impeachment of high officials, the financial panic of '73 had seriously shaken the country, and even conservative European journals commented upon the apprehension of American citizens who hurried their children abroad to school, and saw only the collapse of freedom and general ruin in the alleged Napoleonic ambitions of President Grant. The Centennial Exhibition was to be a symbol and a sign to all doubters abroad and at home, and a year in advance, the press took up the triumphant strain which was to be the theme for the Centennial year, and exhorted the whole land, 'out of its unparalleled prosperity, to exhibit its advance and invite the whole world to be present.'

For five years the plans had gone steadily for-



MODEL OF THE FIRST TELEPHONE

Mr. Bell in Lyceum Hall, Salem, Addressing a Party of Scientific Men in Boston

Reporters and Scientific Men in Mr. Bell's Room in Boston

CUTS IN FRANK LESLIE'S WEEKLY, MARCH 31, 1877

ward. First sods had been publicly turned with spades 'tastefully festooned with red, white, and blue ribbons.' Gradually, the one hundred and fifty buildings and their attendant pavilions and fountains and avenues spread over Fairmount Park's beautiful acres; all the civilized countries of the globe 'except Greece' (who was probably out of funds) sent in their exhibits, and in May, 1876, the exhibition was formally opened and the whole world came.

For the time being in the United States, the Centennial dominated the news. It dwarfed even the nomination of Rutherford B. Hayes and Tilden's candidacy for the presidential office. Newport had a Centennial season and the churches had Centennial sermons. Colorado came into the Union amid plaudits as the Centennial State.

The rejoicing swelled to a roar of welcome for the arrival of the Centennial guest of honour, Dom Pedro, the Emperor of Brazil, who came with his Empress, with a picturesque retinue and an escort of battleships — the three biggest battleships of the Brazilian Navy. The Imperial party came early in the year and stayed late. Dom Pedro wanted to go everywhere and see everything. His interest survived every fatigue of entertainment. He was a guest after the heart of every reception committee, and his active, burly figure, and his square blond beard, are inseparable from all recollections of the Centennial summer. Philadelphia hung transparencies in her streets, draped them in banners, and with prodigal jets of gas illuminated the Nation's sentiment, "Welcome, Dom Pedro."

Dom Pedro was known to be especially interested in North American methods of education. He visited all the principal schools and colleges, and when he was in Boston in early June some one told him of the work of young Mr. Bell, who was teaching the deaf to speak. The Emperor met Mr. Bell at the Boston City School for the Deaf and chatted with him at length on the whole problem of education for the deaf.

(2)

Bell had been much occupied with his teaching during the preceding winter. He had been only partly relieved by his normal school teachers as the spring came in, and with May and June he was still burdened with his classes. In May, the members of the American Academy of Arts and Sciences listened to a paper from him on 'Researches in Telephony,' and then listened at his telephones in the Academy hall and in the Athenæum Library (in the same building), while the lecturer played a parlour organ in his room at the Boston University near by. The paper made a mild stir.

At the Centennial Exhibition, Gardiner Greene Hubbard was in charge of the educational section for Massachusetts, and in that department Bell had entered an exhibit of Visible Speech charts.

Mabel Hubbard now wanted him to exhibit the multiple telegraph and the telephone. For a long time, mindful of needed improvements in his apparatus which he had not had time to make, Bell was unwilling to do so. When at last he consented, it was only to recall that the time limit for the receipt

of entries had expired in April. That finished it for Bell. Mr. Hubbard assured him that it would be the merest detail to add the apparatus to the earlier exhibit. In his official capacity nothing could be easier to arrange. To Bell, whose literal honesty never made concessions, the thing was impossible. If he could not comply with the rules, he would make no exhibit.

The English patent *impasse* was now enacted over again. When Mabel Hubbard had at last persuaded Bell that he could consistently permit the telephone to go to Philadelphia, it was too late for even Mr. Hubbard to get a place assigned to it in the electrical section. So, with the multiple telegraph, it was sandwiched in with the Visible Speech charts in an obscure corner of the educational exhibit from Massachusetts.

In the exhibit there were two membrane telephones, a liquid transmitter and the famous Centennial iron-box receiver which Bell always regarded as the flower of the flock. All of the instruments had been made by Watson upon Bell's last-moment decision.

The annual examinations for Bell's speech classes were set for the last week of June, to begin on Monday the 26th. It was the most important time of his teaching year. And then, a few days in advance, Mr. Hubbard telegraphed from Philadelphia to say that on Sunday, the 25th, the Centennial judges would reach the section containing Bell's exhibit.

It was a most unfortunate coincidence in dates. Both events were of great importance to him. But Bell had learned the truth of the adage about a bird

in the hand. His classes were now his first responsibility and, since he could not overtake both engagements, he decided that he must stay in Boston and look after his pupils. Perhaps he was still a little vexed at having allowed his scruples to be overridden, and now took refuge in the superior claims of his teaching duties. All of Mabel Hubbard's persuasion and all of Mrs. Hubbard's tact were needed to get Bell to go to New York and Philadelphia.

(3)

That was one of the hottest week-ends in the summer of 1876. The humidity soared with the temperature, increasing the discomfort of the crowded trains, and prostrating Philadelphia's throngs of Centennial visitors. Bell found Mr. Hubbard worn out from the heat and the crowds. He had arranged with the group judges to inspect Bell's exhibit on Sunday, but he was tired and wanted to get away. He telegraphed for his nephew, William Hubbard, to come on to assist Bell with his exhibit and when he arrived, Mr. Hubbard left on the same train for Washington.

Bell, who suffered acutely in hot weather, was relieved to present his pass at the Exhibition grounds on Saturday and busy himself with his wires and batteries in the main building's East Gallery. His little exhibit went unnoticed by the throngs who viewed the building's twenty-one acres of printing presses, furniture, furs and ornaments, pottery and glass and railway rolling stock. Ladies in silk grenadine flounces were fanned by their escorts, in

determined tours of everything from Italy's sculpture to the derided bed-quilts in the Woman's Pavilion. Jaded groups of judges moved from exhibit to exhibit, listlessly tasting pickles and bonbons, testing snuff, smoking cigars. In the grounds, thanks to the forethought of the temperance societies, a sculptured Moses struck ice-water from a rock, reviving the multitude free of charge.

Bell's telephone was of course at a great disadvantage out of its proper classification. Without his presence he felt that it must inevitably have been overlooked by the judges.

With Willie Hubbard, Bell went out to the Exhibition early on Sunday, and waited. The buildings were closed to the public on that day; the sixty-five performers of Gilmore's Band were mute, and in the quiet building, the judging committee made its rounds, unimpeded by the tourist throng.

Bell adjusted and readjusted the instruments, in a fever of suspense. The hot hours passed. At last the belated group of judges came in sight. A number of unofficial observers were with them, among these the tireless Dom Pedro, Emperor of Brazil.

The committee moved slowly from one exhibit to the next. They were nearly all gentlemen of middle age, very uncomfortable in their formal attire on that hot day, by this time all very bored and tired, and eager to get back to their hotels. Bell's heart sank as they approached and he heard their decision that the next exhibit should be the last for that day. The next exhibit was the one before his own.

Bell knew that with that adjournment went his one chance of an award. For when the judges re-

sumed their inspection the next day, he would be back in Boston looking after his pupils' examination papers, and without his demonstration the committee would not be able to make head or tail of the telephone, provided that they saw the exhibit at all.

While he watched, the judges turned to leave. They paused deferentially for the Emperor to precede them, and in that pregnant instant Dom Pedro saw Bell. There was no mistaking the pale young man with his jet black whiskers and flashing eyes. This was surely the dynamic young professor with whom he had chatted a few weeks before in Boston. Dom Pedro took the distance in a friendly stride. 'How do you do, Mr. Bell?' he said heartily, 'and how are the deaf-mutes of Boston?'

The judges waited, uneasily. They couldn't leave without their Imperial guest. The Emperor chatted on. Then Bell told him that his exhibit was the next one, and spoke of his disappointment that the telephone apparatus was not to be inspected until the next day, since he must leave Philadelphia that night.

'Ah!' said Dom Pedro, 'then we must have a look at it now.' He took Bell's arm and moved toward the exhibit, and where the Emperor led the way the weary judges followed.

So far as the judges were concerned, however, the demonstration that followed was one of the sensations of the Centennial.

The group was headed by Sir William Thomson (afterward Lord Kelvin), to whose researches the first successful Atlantic cable was largely due. He had been knighted when the cable was successfully

laid in 1866. At the Centennial he was chairman of the Committee of Awards on electrical and related exhibits. Besides Sir William, Professor James C. Watson, of Ann Arbor, Professor T. Sterry Hunt, and Professor George F. Barker were present that day. Dr. Koenig, the inventor of the manometric capsule, was there, and so was Mr. Elisha Gray, whose multiple telegraph had just been exhibited to the judges, and whose generous applause of Bell's achievement in the speaking telephone was to be not the least significant incident of that famous sabbath.

Bell went to the transmitter, while, the width of the building away, Willie Hubbard supervised for the judges the unfamiliar business of receiving speech by telegraph.

Here was a test of the Bell elocution.

Bell began with Hamlet's Soliloquy, that standby of three generations of Bells, which his grandfather had taught him to declaim when he was fourteen.

'*To be, or not to be, that is the question. . . .*'

He recited the whole of it.

At the other side of the building, the heat forgotten, an eager group of listeners hung on their respective turns to press the iron-box receiver firmly to one ear, close the other with a free hand, and marvel at the phenomenon of the human voice traversing five hundred feet of electrified wire. They handed the receiver about in turn. Each listener repeated the snatches of the speech he heard. The delighted company laughed and clapped their hands.

Suddenly Sir William Thomson said, 'I will go

and talk.' Bell was counting, one, two, three . . . 'While I was speaking,' said Bell, 'Sir William came up to observe what I was doing.' Bell handed the transmitter to him. Professor Barker, of the University of Pennsylvania, was listening at the other end. He heard the last few counts, then a pause, and then, he says, 'I heard the well-known accents of Sir William's voice, and said, "Sir William is now speaking."' It seemed most marvellous of all that an individual voice could be recognized over a wire. 'A moment later,' Professor Barker continues, 'I heard him say, "Aye, there's the rub," and repeated the words to the company. I then passed the receiver to the Emperor. He placed it to his ear with an expression of doubt upon his countenance; but immediately this expression changed and he repeated slowly the words, "To be, or not to be."'

The receiver was then passed to Elisha Gray, who heard, 'Aye, there's the rub.' 'I turned to the audience,' he said, 'repeating these words, and they cheered.'

Prophetic words for Elisha Gray to hear over Bell's telephone.

In Sir William's recommendation for Bell's award he afterward said, in part, 'I need scarcely say I was astonished and delighted as were others, including some other judges of our group, who witnessed the experiments and verified with their own ears the electric transmission of speech. This, perhaps the greatest marvel hitherto achieved by the electric telegraph, has been obtained by appliances of quite a homespun and rudimentary character. With somewhat more advanced plans and more

powerful apparatus we may confidently expect that Mr. Bell will give us the means of making voice and spoken words audible through the electric wire to an ear hundreds of miles distant.'

Here was praise from Sir Hubert!

The apparatus had worked perfectly. The judges were clearly pleased and astonished. Bell's award was assured. The occasion lacked nothing of official notice that could convince the most sceptical of the importance of this obscure exhibit in the East Gallery. The distinguished committee of judges congratulated him, the unofficial observers congratulated him, and so did Mr. Elisha Gray. They talked freely and very enthusiastically of the exhibit afterward, yet at the time it brought only the scantiest comment in proportion to the space devoted daily to detailed descriptions of the Exhibition in every newspaper in the country. Two weeks later the Boston *Evening Transcript* commented, under 'Notes at the Centennial,' 'Professor Bell has also a telegraphic and telephonic apparatus in this department for the transmission of many messages over a single wire, and of musical and articulate sounds by telegraph. The experiments, which have been made in the presence of the Emperor of Brazil, Sir William Thomson, and others interested in the subject, have been highly interesting and satisfactory in their results.'

So far as the Centennial visitors were concerned, the device that was to affect the world's social and economic structure perhaps more profoundly than any other discovery of the century, 'the greatest by far of all the marvels of the electric telegraph,'

attracted less notice than the packages of parlour magic on sale in the pavilions.

The scant attention paid to Sir William Thomson's glowing and prophetic phrases is an interesting commentary on the times. It is difficult to think that nowadays such an endorsement from the first scientist of the day in his field, would fail to impress capital looking for profitable inventions to exploit. But perhaps our blindnesses are only different in kind. An eminent American lamented not long ago that there are now no outstanding men of genius in any country. Perhaps his prototype of 1876 looked disparagingly about the Centennial Exhibition and said, 'There is no genius here.'

Before the judges left the East Gallery of the Centennial that June afternoon, they asked Bell's permission to remove the apparatus to the Judges' Hall on Monday for further tests. Sir William wanted Lady Thomson to listen to it. Bell consented with misgivings, fearing that in removing it the connections might be disturbed. But he had to be back in Boston the next day and he decided to take the chance. Initially, he does not seem to have held any high opinion of the proffered aid of young Mr. William Hubbard, who, nevertheless, acquitted himself nobly in the matter. Willie Hubbard was present later that Sunday when Elisha Gray called on Bell at his hotel to chat pleasantly about the events of the afternoon, and to renew his friendly congratulations on the performances of the electric speaking telephone. Bell took the night train out of Philadelphia. It was his only visit to the Centennial.

Meantime, Professor T. Sterry Hunt drove back

to the Continental Hotel and dined with Sir William Thomson. Out of the contagion of Sir William's enthusiasm, before he retired, Professor Hunt wrote a charming letter which reached Bell in Boston and must have consoled him no little for his enforced preoccupation with his pupils' examination papers in that electric hour.

My dear Mr. Bell [wrote Professor Hunt],

I am informed that you leave to-night for Boston, so I take this way of congratulating you on your success today. I returned to my hotel with Sir William Thomson, and dined with him. He speaks with much enthusiasm of your achievement. What yesterday he would have declared impossible he has to-day seen realized, and he declares it the most wonderful thing he has seen in America. You speak of it as an embryo invention, but to him it seems already complete, and he declares that before long, friends will whisper their secrets over the electric wire.

Your undulating current he declares a great and happy conception.

All this he discussed partly with Dr. Bache and more at length with Sir Redmond Barry and Sir John Hawkshaw. Sir William leaves here on Friday for Montreal and will visit Boston for a day or two before sailing, which will be from New York July 19.

Thinking you would be glad to know the judgement of one so eminent, I have written you this, and I am, my dear Mr. Bell,

Always truly yours

T. Sterry Hunt

P.S. Do you know anything of Brucher's system of visible speech, of which one of the Austrian judges spoke to-day? It seems very like your father's.

Graham Bell, Esq.

Presently Bell had a triumphant telegram from young Mr. William Hubbard, who was pardonably pleased with himself for moving the telephone exhibit without mishap to the Judges' Hall. There he had set it up for further tests by Sir William Thomson and his confrères. They were all more impressed than ever. Sir William and Lady Thomson ran back and forth between the instruments 'like a pair of delighted children'; and the assembled scientists became so excited and made so much noise that the police thought the building was on fire.

(4)

The happy and encouraged inventor now prepared to transmit speech from Boston to Philadelphia, if the test should be requested by the judges. He enlisted friends to sing for him — young men who came to the Brattle Street house — and wrote detailed instructions with copious diagrams to Willie Hubbard preparing him for his rôle at the Philadelphia end:

CAMBRIDGE, MASS, *July 2d*, 1867

[In his excitement and haste Bell wrote 1867 for 1876]

MY DEAR WILLIE:

For the fourth time to-day I commence an epistle to you. I am determined to write you a letter in spite of all the obstructions thrown in my way — for I think you deserve a real good-hearted letter as long as from here to Philadelphia for all that you have done for me and my telegraph. . . .

Willie Winlock and Bert Eustace went into Boston to help me on Thursday in case it was decided to work my instruments between Boston and Philadelphia. They were to sing for me. . . .

Having completed my list of messages, I must really now speak of my telegraphic instruments. I can't tell you how glad I was to receive your telegram about your exhibit before Sir William. Mrs. Hubbard and *all the family* feel very proud of you for being able to exhibit so successfully my electrical apparatus. I had no idea that you would have to remove the apparatus to the Judges' Hall. Poor fellow, what a time you must have had! I really do feel very proud of you that you should have made everything go smoothly. I am very anxious about Saturday. What should I have done without you or rather what should I do now without you? I am afraid you must think me very ungrateful for not having written, but the fact is, that in preparing for transmitting sounds to Philadelphia from here, I made such a startling discovery that I have been unable to do anything else since but experiment. In order to attempt the transmission of speech to Philadelphia, it was necessary to have a telephone constructed, the magnet of which should have a resistance equivalent to a considerable portion of the total resistance of the telegraph line between here and Philadelphia. The resistance of the line is over 5000 ohms. Now I have had two magnets made, the coils of which offer a resistance of 3250 ohms both together. It would require a battery of many cells in order to operate a Morse sounder through such a resistance. It is as great a resistance as 325 miles of well-insulated telegraph wire. My discovery was that I could work my apparatus with *one cell of battery* through this resistance. I am sure by substituting a *permanent magnet* for the pole of the electro-magnet, I could work it *without a battery at all.*

With love and best wishes
Yours sincerely
A. GRAHAM BELL

MR. WILLIAM HUBBARD
East Gall., M.B.
Exhibition Building, Philadelphia

P.S. Should I send on apparatus to Philadelphia and

you make the connection, simply connect the instrument with the line wire and the earth like this, —

[diagram]

A.G.B.

You can increase musical sounds by resting bridge of violin against A.

But the test to Philadelphia was not required, and so it fell out that the first long-distance transmission of speech took place, later, over a Canadian wire.

(5)

The events of the next fortnight are lost in the celebration of that extraordinary, kaleidoscopic Centennial Fourth of July. In New York the celebration began at midnight of the 3d with united military bands, numbering three hundred pieces, performing 'Hail, Columbia,' to the accompaniment of fireworks. It continued with the pealing of chimes, ringing of church bells, firing of cannon; with bonfires and torchlight processions, and persisted in a delirium of noise and impact through the night and the whole of the next day. There had never been such a Fourth of July. There has never been one like it since. Glee clubs and Mendelssohn choirs everywhere sang William Cullen Bryant's 'Hymn to the Centennial.' Bayard Taylor declaimed his long poem 'in a strong full voice' at Philadelphia. All over the country thousands of Chinese lanterns bobbed in the dark foliage of a hundred squares, flags flew, the Veterans of 1812 paraded, and in the North the Grand Army of the Republic turned out in uniforms still a tolerable fit. Bands played everything from 'Hail to the Chief' to 'Yankee Doodle,'

and when their repertories were exhausted they played everything together and called it 'Centennial Fantasia.' It was a glorious speeding-up of the programme forecast by John Adams, when he wrote to his wife from Philadelphia in 1776: 'The fourth of July . . . ought to be solemnized with pomps, shows, games, sports, guns, bells, bonfires and illuminations, from one end of the continent to the other from this time forward forever'!

Bell had a busy week arranging experiments in anticipation of the arrival in Boston of Sir William Thomson, who was still declaring Bell's telephone the most amazing thing he had seen in America, and who wanted to see more of it. Two tests were made, on the 7th and the 9th, with telephones placed in different rooms of the Equitable Building. On the second occasion the wire was grounded in New York and Bell played tunes on a parlour organ while a New York operator put his ear to his relay and wired that he could hear 'elegantly.' Bell telegraphed to ask what he heard. He wired back, 'Yankee Doodle.'

On the 12th of July, Sir William arrived in Boston. The Atlantic and Pacific Telegraph Company lent their wires and their quarters in the Equitable Building, where some conversation was exchanged between two rooms. There was a small paragraph about the test in next day's *Transcript.*

After the experiments were over, the instruments were presented to Sir William, but since there was no time to have them properly packed, they were wrapped up in brown paper and without other protection went into his luggage.

(6)

Late in July, Bell put two of his membrane telephones, an iron-box receiver with assorted coils of wire into his bag, and went home for his summer holiday in Brantford. There, in early August, in Bell's own words, 'articulate speech was for the first time transmitted and received between places that were separated by miles of space.'

Three experiments of that month, each confirming the triumph, were to become historic. In all of them the membrane telephone was used as a transmitter and the iron-box apparatus as a receiver. The apparatus was not designed to transmit and receive conversation simultaneously, so messages went only one way by telephone and the replies came back by telegraph.

Before the long-distance tests, however, Bell had a triple mouthpiece made for the membrane telephone. It seemed so much more wonderful to every one that two or three voices could be heard at the same time than that the electric current could carry one voice distinctly. Besides, part songs were the vogue, and all the Bell cousins sang. A wire was run from the verandah to one of the outbuildings at Tutelo Heights, and everybody took turns first at the mouthpiece and then at the receiver. When there was no one available to share the trials, Bell strung a wire around the eaves of the house, and sat telephoning to himself in his own room.

The family had friends in the little town of Paris, eight miles away from Brantford. It was in Paris that the Bells had stayed for the first few days when they came to Canada. Arrangements were made

with Mr. Griffin, manager of the Brantford office of the Dominion Telegraph Company, to use the wires of the company between his office and the Paris office. Bell connected the membrane telephone and its triple mouthpiece at the Brantford telegraph office. Then he got a buggy and drove the eight miles to Paris, carrying the iron-box receiver and an extra high-tension coil wrapped up on his lap.

His father had another engagement that day and could not be present to help with the Brantford programme, so Bell arranged with his uncle, David Bell, to be at the telegraph office to recite into the mouthpiece, and direct the singing of the volunteer performers. David Bell, co-author of the 'Standard Elocutionist' and also a teacher of elocution, could, Bell said, 'recite Shakespeare by the hour.' That was what his nephew wanted; clear, sustained elocution, and lots of it.

At the Paris telegraph office he connected the receiver, and listened. There was a storm of 'bubbling and crackling sounds,' but through them, 'in a faint, far-away manner,' Bell could hear the voices of singers and speakers in Brantford.

Low-resistance coils were being used. Bell telegraphed to Mr. Griffin by another line and asked him to substitute an electro-magnet with coils of high resistance. While this was being done, Bell made the same change in the receiving apparatus. There were still noises on the line, but now the speeches came through so distinctly that Bell could recognize the voices of the speakers. 'First I heard a cough, then a voice which said — "To be, or not to be."' Aleck was listening for his uncle's voice, but 'it

sounded so like my father's that I telegraphed to Brantford to ascertain whether it could possibly be his, for I had understood that he could not be present at the time. He was present, however, and it was his voice that I had heard.'

It was to be.

This was the most astonishing feat which the telephone had performed up to that time. The speakers were in Brantford, the listener in Paris eight miles away, and the battery used was in Toronto, some sixty-eight miles off. In honour of this event, and of his son's Centennial successes, Melville Bell now announced a public reception at his house for the 4th of August. Aleck wanted to demonstrate the telephone to the guests, but the nearest telegraph wire — the line that ran to Mount Pleasant, five miles away — was strung a quarter of a mile from the Bell house on the Mount Pleasant road.

Meantime, however, the manager of the Telegraph Company again offered to coöperate. The day before the reception, Bell drove off to Mount Pleasant to test the wire, and found to his delight that he could hear speakers in Brantford just as well as he had heard them in the Paris test. All that remained was to connect the Mount Pleasant wire with his father's house. Bell rushed back to Brantford and bought up all the stovepipe wire in town. Hammer in hand, with a pocketful of tacks, he tacked the wire along the wooden fences leading from the road up to the farmhouse, and grounded the connection. When all was in readiness the main line to Mount Pleasant was cut, and, while the Bell guests listened, the third long-distance programme

was sent from Brantford to Tutelo Heights on the line pieced out with stovepipe wire. Only a few years ago the wire was still there, looped in rusty lengths along the fences, where Bell had strung it that August day in 1876.

A paragraph on the occasion was communicated by the Brantford *Expositor* to the Toronto *Globe*, where it was run 'in an obscure place, without a heading' on August 11:

We are informed, by the *Expositor* that at the party at the residence of Professor A. Melville Bell, Brantford, on Friday evening, August 4th, a rare treat was afforded to the guests in the experimental explanations made by Professor A. Graham Bell, of Boston, of the new system of telephoning invented by that gentleman. Instruments were placed, one in the porch of the residence, and the other in an outhouse on the grounds, and communication between these made by ten miles of wire. Musical notes, the human voice, and songs spoken and sung before one instrument were plainly audible by placing the instrument to the ear at the other. By this invention too any number of messages can be conveyed over one wire in either direction, provided they have a different pitch. The tone of the voice can pass over the electric wire enabling the hearer at any distance to hear distinctly what is said and to distinguish the voice of the speaker. On Thursday the Professor had communication made with his instruments on a common telegraph wire, between Brantford and Mount Pleasant (five miles) by Professor D. C. Bell and Mr. Griffin, from the Dominion office in Brantford. On Saturday evening the Professor tried a new experiment, having had an instrument made so that three persons could sing different tunes or different parts of the same tune into the instrument at the same time. The trial was perfectly successful, the different voices coming distinctly over the wire at the same time, so that they could be separately distinguished by the listener.

The practical exemplification of the lately discovered system of telephoning made by the Professor afforded much pleasure and information to those present.

This polite, if tepid comment notwithstanding, the majority of the Bell neighbours seem to have been as sceptical of the telephone as were Bostonians of the seventies. Only a few years ago the writer was aboard the little Bras d'Or Lake steamer that passed Alexander Graham Bell's Cape Breton estate several times a day. Two visitors leaned against the rail near by as the big house, with its wide stone chimney, came in sight among the trees, above the red bluffs. One of the twain pointed it out to his companion. 'That's Bell's place,' he said. 'Say, do you know, when I was a kid he was working at the telephone up in Brantford. "Crazy Bell" they called him. Used to have wires strung along the fences. Yes, sir, everybody thought he was a regular nut. They've got a wonderful monument up there now, the Bell Memorial. "Crazy Bell"! That's his place. Can you beat it!'

CHAPTER XI

(1)

THAT summer of 1876, Mr. Hubbard offered Thomas A. Watson a tenth interest in the Bell patents if he would give up his job at Williams' shop and devote all his time to making apparatus for Bell. Watson was pleased with this recognition of his worth, but not impressed with the proposal. He had, he said, 'a good job at Williams', earning journeyman's wages — three dollars a day — and putting money into the savings bank every month, and was in line for the foremanship of the establishment.' Doubtless he received plenty of sage counsel about the unwisdom of such a move, for he took two weeks to make up his mind to accept. Then the contract was concluded — at first for half of Watson's time.

Up to this time Watson had still been commuting between Salem and Boston. Now he moved in to the attic room adjoining Bell's in the lodging-house on Exeter Place. Its late occupant, Henry Davies, an actor at the Boston Theatre, had been driven out, Watson surmised, 'by the noise Bell and I made with our experimenting.' This arrangement gave them the whole attic floor and the needed privacy.

Bell had returned to Boston to find, if not fame, at least lively interest in his electric speaking telephone. The Philadelphia *Record* had mentioned the Brantford tests of August and, on September 9, the *Scientific American* published an article, 'The Human Voice Transmitted by Telegraph,' based on the same

experiments. Bell cut the articles out and pasted them carefully in his scrapbook. Late in September, there were more echoes from Sir William Thomson, this time in print.

On his return to England from his Centennial visit, Sir William had opened the meeting of the British Association at Glasgow with an address which was to be momentous to the Bell interests long afterward. On the voyage to England the telephone instruments, still in their brown paper wrapping, had been jolted about in Sir William's luggage. Watson had screwed down one edge of the metal diaphragm to prevent its loss, and in transit this circular bit of metal got cocked up on its side, still held on the other edge by the screw. When Sir William attempted to demonstrate the instrument to his fellow members, the diaphragm was still tilted up on one edge instead of lying flat in contact with the electro-magnet, and consequently it would not work. And in that great body of distinguished scientists no one — not even Sir William, who grasped Bell's 'great and happy conception' — realized that it should be bent down again. Here was proof, if any were needed, of the entire novelty of Bell's speaking telephone. But whether he could make it talk or no, Sir William went on with his address. Published in England in the scientific journal *Nature* it was reprinted in part for American readers in the Boston *Daily Advertiser* of September 25. It said:

In the United States telegraphic department I saw and heard Elisha Gray's splendidly worked-out electric telephone actually sounding four messages simultaneously on the Morse code, and clearly capable of doing yet four times

as many with very moderate improvements in detail; and I saw Edison's automatic telegraph delivering 1015 words in 57 seconds: this done by the long-neglected electro-chemical method of Bain, long ago condemned in England to the helot work of recording from a relay, and then turned adrift as needlessly delicate for that. In the Canadian department I heard 'To be or not to be... there's the rub' through an electric telegraph wire; but, scorning monosyllables, the electric articulation rose to higher flights, and gave me messages taken at random from the New York newspapers — 'S. S. Cox has arrived' (I failed to make out the S. S. Cox); 'The City of New York.' 'Senator Morton.' 'The Senate has resolved to print a thousand extra copies.' 'The Americans in London have resolved to celebrate the coming 4th of July.' All this my own ears heard, spoken to me with unmistakable distinctness by the thin circular disc armature of just such another little electro-magnet as this which I hold in my hand. The words were shouted with a clear and loud voice by my colleague-judge Professor Watson, at the far end of the telegraph wire, holding his mouth close to a stretched membrane, such as you see before you here, carrying a little piece of soft iron, which was thus made to perform in the neighbourhood of an electro-magnet in circuit with the line motions proportional to the sonorific motions of the air. This, the greatest by far of all the marvels of the electric telegraph, is due to a young countryman of our own, Mr. Graham Bell, of Edinburgh and Montreal and Boston, now becoming a naturalized citizen of the United States. Who can but admire the hardihood of invention which devised such very slight means to realize the mathematical conception that, if electricity is to convey all the delicacies of quality which distinguish articulate speech, the strength of the current must vary continuously and as nearly as may be in simple proportion to the velocity of a particle of air engaged in constituting the sound?

(2)

Since his arrangement of early September with Watson, Bell's experiments had been principally concerned with the multiple telegraph. By the end of the month it was subordinated in the Exeter Place workshop and Bell and Watson 'began a period of intense work on the telephone.' Bell began to draft the specifications for his English patent.

Bell and Watson had nothing to guide them excepting what they could discover for themselves. This delicate, voice-generated current of Bell's led them away from all the known paths in telegraphy, and, little as they knew of the unexplored territory before them, at least no one else knew as much. It was a situation to stir all Bell's imagination and energies. Trodden paths bored him. He was never so happy as when he led off into just such a trackless unknown.

'We systematized the experiments by varying each part of the telephone in turn in every possible way, while keeping the other parts constant. The parts were few — the electro-magnet and its coils, the diaphragm, and the mouthpiece, with either a battery or a permanent steel magnet to excite the electro-magnet — but the work was difficult.'

In varying the diaphragm, for instance, in order to find its most efficient size and thickness, they had to construct telephones with all sizes of diaphragms from one of boiler-plate iron, three feet across and an inch thick, down to a minute instrument incorporating the internal mechanism of the human ear — a genuine ear supplied again by Dr. Clarence J. Blake. 'They all worked,' says Watson, 'even the real ear

telephone, which was, however, the poorest of the lot.'

Bell always remembered as one of his dearest achievements the success of that diaphragm of boiler-plate iron. It was proof to him that whatever the improvements in the Art, despite carbon in the transmitter, hard-drawn copper wire and loading coils in the circuit, the telephone was his. That boiler-plate metal had talked. He was to remember it fondly as the most efficient of the early telephones — 'boiler-plate iron, so thick that you could sit on it!'

Regardless of the performance of this giant, however, the diaphragm finally adopted by Bell was, as Watson says, of the same size and thickness as the one used to-day.

(3)

On Hubbard's advice, Bell had long been in the habit of writing letters describing the progress of his work. Now he became more than ever impressed with the need for daily notes. His record of experiments had expanded into its second volume, and on October 7th he wrote:

> The experiments have been irregularly conducted during this week and have not been noted in consequence of omission to procure a new book. We are convinced of the very great importance of noting every experiment at the time it is made, as the remembrance so soon fades away. A number of experiments made during the last few days have been forgotten.

He then noted this exchange.

> Watson spoke with his mouth almost in contact, cupping his hands —

Bell — If you understand what I say, say something to me.

Watson — It is (decidedly) the best I ever saw.

Bell — It is the best *I* ever heard.

Watson — Success at last has (attended) our efforts.

Bell — 'Let us then be up and doing
With a heart for any fate.
Still untiring, still pursuing,
Learn to labour and to wait.'

He put it down carefully, bracketing the words not understood, misquotation and all.

Seventeen-year-old Eddy Wilson, one of the lads from Williams' Shop, was engaged to sing into the telephone while Bell listened. Eddy emerged from the record, such was Bell's punctilio, as 'Mr. Edward Wilson.' Bell said, years later, 'Mr. Watson superintended the construction of the apparatus, and, as a general rule, when we tried experiments, he was at one end of the circuit and I at the other. It was sometimes convenient, however, to employ some friend to shout, and speak, and listen at the other end of the circuit, instead of troubling Mr. Watson and taking him from his work. I think Mr. Edward Wilson sometimes assisted me at that time — July 1876 — in this way, and other friends occasionally helped me in the same manner.' One is left to conjecture what Eddy's thoughts may have been as he roared 'Yankee Doodle' into the telephone that Centennial summer.

By trial and error they felt their way in the new field which Bell had discovered and in which, in his hardihood of invention, they were the only comers. They varied the sizes of cores in their electro-magnets, varied the sizes and shapes and resistances of

the coils. At last they felt that they were ready for conversation on a real line.

The Walworth Manufacturing Company, with an office in Kilby Street, Boston, had its own telegraph line to its factory in Cambridgeport. The line was about two miles long. On the 9th of October, Bell got permission to use it, after both of the offices had closed for the day.

Notwithstanding the attention that the telephone had received through its exhibition at the Centennial and the notice of Sir William Thomson, no one took its commercial possibilities with any real seriousness at this time. No one, that is, excepting its inventor. It was admittedly a very wonderful device, speech had certainly been sent and received over a wire by its means, and the optimists saw its usefulness as a competitor of the speaking tube. But it was regarded generally as an ingenious scientific toy. Commenting editorially on the novelties of the Centennial the New York *Tribune* said of the telephone about this time:

> Of what use is such an invention? Well, there may be occasions of state when it is necessary for officials who are far apart to talk with each other without the interference of an operator. Or some lover may wish to pop the question directly into the ear of a lady and hear for himself her reply, though miles away; it is not for us to guess how courtships will be carried on in the twentieth century. It is said that the human voice has been conveyed by this contrivance over a circuit of sixty miles. Music can be readily transmitted. Think of serenading by telegraph!

The kindest of its critics, a friend of Bell's, who had some acquaintance with scientific matters, ex-

plained privately to Watson that since every spoken word has many delicate vibrations to be converted into electric waves by the telephone, the message would not be intelligible if any of them got lost. Obviously any device so liable to error could never have any practical value.

It was never Bell's way to compromise with a situation of this kind. He was about to make an important test over two miles of wire. Apparatus that operated successfully in the laboratory might develop some flaw under the new conditions and it might have been the part of discretion to have postponed announcement of the trial. Bell did nothing of the kind. He announced the event and he instructed Watson to write down in parallel columns the messages he spoke and the messages he heard. Bell would do the same. Afterward they would let his critics compare the two and let his claims for the performance of his telephone rest on the result.

So Watson went out to Cambridgeport, his telephone, a bundle of wire, and his tools wrapped up in a newspaper under his arm. The factory building, closed for the night, was in charge of a watchman. Watson disconnected the telegraph instruments, connected and adjusted the telephone, pressed the diaphragm to his ear in agitated suspense, and listened for Bell's voice. Watson had reason for his agitation. He heard more criticism of the telephone than its inventor did, and he had not the confidence in its long-distance powers that the Brantford tests had given Bell. He listened, holding his breath: 'Not a sound could I hear, although I knew Bell must be shouting. I shouted into my instrument

and listened again. Nothing but black dismal silence! I looked over the connections, readjusted the telephone, then listened and called again.'

Still there was no sound from that metal disc that had functioned so perfectly in the Exeter Place workshop. Watson remembered the 'croakers' and little frantic doubts began to crowd his mind. 'Could it be that, although the telephone would work all right between two rooms, it would not do so under regular telegraph conditions? I knew we were using the weakest current ever used for any practical purpose and that it was also of a very high intensity, for we had talked successfully through a circuit made up of a dozen persons clasping hands — a very great resistance. Was it possible that the glass insulators that were right for the telegraph current would not hold our much more intense current to the wire? Did a little leak to the ground at every support so that none of the electric undulations from Bell's voice got across the Charles River to where I was?'

But all the time that his mind was full of questionings, Watson's hands were busy with manipulation and adjustment, trying to find some clue to the failure: trying to make the telephone talk. 'But it was useless, the thing was obstinately dumb.'

Watson was just about to disconnect the telephone, reinstall the telegraph instruments, and telegraph his failure to Bell when he thought of something, which he says, 'I should have thought of before.' There might be another telegraph relay in some other part of the factory connected into the wire he was using. If there was, he knew it would

wipe out their delicate voice-generated undulations. The watchman had been an uneasy witness of all this frantic behaviour, 'watching me,' Watson said, 'as if he thought I must be crazy, shouting into a brass contraption and expecting some one over in Boston to hear me!' Now Watson asked whether there was another telegraph instrument in the building. The watchman did not know. He wasn't going to have anything to do with these goings-on. Watson wanted to be shown where the wire entered the factory, and unwillingly, for he didn't like it at all, the watchman showed him and followed with his lantern while Watson traced the wire through the building. It led to the door of one of the offices and when the watchman unlocked it and flashed the light of his lantern inside, Watson saw to his relief the relay he had suspected.

'I cut it out with a piece of wire across its binding posts, rushed downstairs followed at a much slower pace by the watchman, and listened at the telephone.

'It was no longer dumb! More loudly and distinctly than I had ever heard it talk between two rooms, Bell's voice was vibrating from it, shouting, "Ahoy! Ahoy! Are you there? Do you hear me? What is the matter?" I could even hear that he was getting hoarse, for he had been shouting all the time I had been hunting over the factory building. I ahoyed back and I could hear his sigh of relief as he asked me, "Where have you been all this time?" in a tone that indicated he thought I'd been loafing.'

Then they began the first long-distance conversation ever held. In the Brantford tests of the previous

August, speech had been sent only one way, from a transmitter at one end to a receiver at the other, the replies travelling by telegraph. Now the telephone had reached reciprocal conversation.

Bell and Watson began to put it down as arranged. The parallel record of their exchanges was published afterward in the Boston *Daily Advertiser*, 'to prove to the doubters that the telephone could talk straight.' It related chiefly to the various adjustments made as they went along, cutting out the battery, replacing it, and so forth:

Bell: Did you hear anything now?
Watson: No, not a sound.

Both paused to write this down. Then —

Bell: We may congratulate ourselves upon a great success.
Watson: We deserve success. Both batteries are on now . . . .

They asked each other to repeat. Bell told Watson to whisper, and he could hear the whispering, but could not understand what he said; he asked Watson the time by his watch. Then they thought they had done enough for the record — it was long after midnight; but they went on talking, these excited young men separated by two incredible miles. Watson let the watchman listen, and since he had to be up anyway he listened, but even then, said Watson, 'I think he felt it was some humbug.' He was very evidently relieved to let Watson out of the building toward morning to walk back to Boston, his contraptions wrapped up under his arm.

By this time Watson had known Bell long enough

to pick up a creditable performance in the war-dance with which Bell was accustomed to celebrate his successes. When they reached Exeter Place toward morning, forgetful of the other occupants, they abandoned themselves to the war-dance of their lives. And since no good war-dance can be done in silence, it is very likely that they whooped a little too. This rejoicing, Watson said, 'nearly resulted in a catastrophe, for the next morning, after a sleepless night, as I started downstairs to go to Williams' to build some more telephones, I saw our landlady waiting for me at her door with an acid expression on her face.' The landlady had her own troubles, and she felt that she had been putting up with a lot of unnecessary goings-on, what with shouting back and forth at all hours of the night and visitors forever on the stairs. Watson felt an impending storm and affected urgent haste. But she stopped him. 'I don't know what you fellows are doing up in that attic,' she warned him, 'but if you don't stop making so much noise nights and keeping my lodgers awake, you'll have to quit them rooms.'

Watson was conciliatory — they were a little behind in their rent.

(4)

Two days after the Cambridgeport experiment, Bell discussed its results before the American Academy of Arts and Sciences, exhibiting the telephones employed, and the Boston *Daily Advertiser* of the following Saturday gave it this notice:

At a meeting of the American Academy on Wednesday night, Professor Bell exhibited his wonderful discovery by

which sounds may be transmitted through wires by means of the electric current. By the invention of peculiar apparatus, conversation may be carried on through hundreds of miles of wires with the greatest ease.

Late in October, Watson went down to visit the Centennial Exhibition before it closed, and Bell busied himself with the provisional specification for his British patent. He was spending a great deal of time now at the Hubbard house in Cambridge. Mabel Hubbard diligently copied his rough drafts in her pretty, clear hand, and put them away for him in her own desk where she had kept his first specifications.

Imitating conditions of a long line by supplying artificial resistances in the workshop did not satisfy Bell. He wanted a 'real line' to work with. The Cambridge Observatory had a wire connected with the office of George & Stearns, electricians, at Number 39, Pearl Street, from which the Observatory's signals were sent to various Boston clock-makers. The time line was not in use at night, and it was not difficult for Mr. Hubbard's protégé to get permission to use it when the clock-makers were abed. When Watson got back from Philadelphia, a line was run from Exeter Place over the housetops to the Pearl Street office of George & Stearns. Now, from time to time, when Bell went to spend his evenings or stay for the night at Brattle Street, he took a telephone along to the Observatory, while his assistant stood faithfully by in the workshop for Bell's 'Ahoy, Watson, are you there?'

(5)

The telephone talked, but only moderately well. 'The apparatus was delicate and complicated,' Watson said, 'and it didn't talk distinctly enough for practical use.' 'November, 1876,' he said, 'was one of the most discouraging periods in the development of the telephone I can remember.'

Bell was a theorist. What he needed now was expert knowledge of electricity. 'But we had both used up our ideas,' said Watson, 'and couldn't think of anything else to make the telephone work better.' Watson, retained at nine dollars a week to make a practical instrument, felt his responsibility. He spent days in the Public Library in search of some hint — something that would suggest a new adjustment that would help them away to a fresh start. One day, in desperation (unknown to Bell), he decided to consult a 'medium.' The newspapers of the seventies were full of advertisements of those confident seventh daughters who read life from the cradle to the grave, advised on business, and love, reunited the separated, located minerals, and revealed the future. Watson selected a lady whose announcement seemed promising. He arranged for a sitting, but received such 'rubbish' that he abandoned hope of occult guidance and went back to the books of the Public Library. One gray day in November he found what he wanted. In a book on the telegraph he stumbled upon a description of a quick-acting magnet used in the Hughes Printing Telegraph, very much the same sort of magnet as those Bell and Watson had used months before, but more delicately constructed. The term 'quick-

acting' decided it for Watson. This was the magnet for the telephone.

Watson lost no time. In an hour or two he had the new magnet ready. 'To my great joy,' he said, 'the thing talked so much better than any other telephone we had tried up to that time, with either electro or permanent magnets, that from that moment all telephones requiring electro-magnets and batteries went into the discard.'

They had used permanent magnets in telephone experiments months before this and, using them, the telephone would talk without a battery; but not so well as a telephone having the electric magnet charged by a battery. So all the recent struggles to improve its speaking capacities had been made with the battery arrangement. Now they went back to the old method, combining this new quick-acting magnet with the other improvements in the apparatus, which, Watson says, 'gave the entire machine an uplift, pulled us out of the slough of despond we were wallowing in and started us going again in a line that had not yet been exhausted.' 'This occurrence,' Watson concludes, 'illustrates the elusiveness of a new invention.' It also illustrates the intelligence and resource of a young man named Watson without whose efforts the practical development of the telephone would have been long delayed.

Another trial over a long line — the wires of the Eastern Railroad Company — was made between Boston and Salem on the last Sunday in November. Bell went to the Boston office; Watson to Salem. The Boston *Post* for the next morning, Monday, carried the following account:

ELECTRIC TELEPHONY

Some More Satisfactory Experiments by Professor A. Graham Bell — Sending Vocal Sounds Two Hundred Miles

The experiments in electric telephony, which Professor A. Graham Bell has been conducting for several years past, have resulted in the development of apparatus by means of which the human voice, as ordinarily used in speaking, can be transmitted with certainty and ease to an indefinite distance — assuredly hundreds of miles. The contrivance is exceedingly simple, and the expense is considerably less than the cost of an ordinary Morse Sounder. The application of this discovery promises to completely revolutionize the business of transmitting messages by electricity between distant points.

The latest experiments with the telephone were made yesterday over the wires of the Eastern Railroad, that day being selected because the trials would not then be interrupted by the ordinary business of the line. Professor Bell, President Rockwell of the Eastern Road, and his wife, Miss Stearns, Mr. Morrison, and Mr. Hubbard, besides two telegraph operators, were the occupants of the Boston office. The instruments were arranged for about a twenty-mile test, consequently Salem, about sixteen miles away, was the point at which a second telephone was fixed. Mr. Thomas A. Watson, assisted by the Salem operator, was in charge there. All those at the Boston end of the line held free and easy conversation with the Salem office, even a whisper or a loud breath being distinctly heard at either end when given at the other. A remarkable instance of the extreme delicacy and faithfulness of the instrument was shown in the fact that when Mr. Hubbard first addressed the listener at the Salem end of the line, Mr. Watson instantly recognized his voice and called him by name before replying. Instead of grounding the wire at Salem, that office was made a way-station, the through line extending to North Conway, one hundred and forty-three miles away. To give

a more exacting test the Boston instrument was then attached to the Portland wire and the circuit made complete from Boston, through that city to Salem, a distance of about two hundred miles. The voice could be heard with considerable clearness after having passed over this great distance, but owing to the unfit construction of the telephones for the duty required of them (they being arranged for about twenty miles), a distinctness was not attained which would allow a conversation to be carried on. Professor Bell is continually improving his invention, and he doubts not that he will ultimately be able to chat pleasantly with friends in Europe while sitting comfortably in his Boston home.

Notices of the same general tenor appeared on the same morning in three other Boston papers. And Boston, drinking its tea, read and smiled at the picture of Professor Bell's ultimate chat with friends abroad.

The next Sunday, the Eastern Railroad Company again gave the use of its line, this time to North Conway, New Hampshire. On Saturday, Watson journeyed up to New Hampshire, carrying with him a mass of apparatus with which to vary the tests over 143 miles of wire — the longest wire they had yet used. That Sunday afternoon he connected the telephone at the little telegraph office and listened, through the storm of crackling and bubbling sounds, for the familiar 'Ahoy! Ahoy! Watson, are you there?'

(6)

Bell went home for three days in Christmas week. He had to be in Washington for the hearing in the Harmonic Telegraph Interferences on the second of

January, and — like any other young man in love — was preoccupied and impatient to be off again, to spend a day or two in Cambridge before he went on to Washington. While visiting at Brattle Street, Mr. Hubbard told Bell that he had heard of a Professor Dolbear, of Tufts College, who was making some experiments with the telephone. Bell's old lodging-house neighbour, P. D. Richards, had been employed by Hubbard as an assistant in charge of the educational exhibit at the Centennial and had spoken of Professor Dolbear's experiments. They seemed of no special importance to Bell, who had arrived at the same results long before. He said as much to Mr. Hubbard and the matter dropped. That Christmas week Bell's mail brought him the award of the judges of the Centennial Exhibition, for his multiple telegraph and for the electric speaking telephone.

CHAPTER XII

(1)

EIGHTEEN SEVENTY-SEVEN. All over India, that New Year's day, gorgeous Maharajas rode on elephants to hear the Queen of England proclaimed Empress. In Berlin, the aged Emperor William received all his generals to celebrate the seventieth anniversary of his entry into the army, and in the United States, official Washington plodded to the last White House reception of President and Mrs. Grant in one of the severest snowstorms the capital had ever known. In New York, that week, Commodore Vanderbilt died, and young Mr. Frederick May knocked down Mr. James Gordon Bennett on the steps of the old Union Club. Public excitement and speculation were divided between the terms of the Vanderbilt will and rumours of the impending Bennett-May duel. In Washington the inventor of the telephone worked on his specifications for a new patent.

On the 13th of the month, Bell took his telephones to the Saturday meeting of the Philosophical Society and explained them to a distinguished company, headed by its president, Joseph Henry, the Secretary of the Smithsonian Institution. Cleveland Abbe was there, and Simon Newcomb, the astronomer, great men leaning forward in their chairs, intent upon this very interesting invention of young Mr. Bell's. The occasion was noted in the Proceedings of the Society:

116th meeting.
The President in the chair.
Forty-nine members and visitors present.
Mr. Alexander G. Bell, of Boston, made a communication on

THE TELEPHONE

When he was through, 'Mr. Hilgard and Mr. Henry spoke of the value and astonishing character of Mr. Bell's discovery and invention.' Both Professor Henry and Mr. Hilgard had been members of the Centennial committee of judges which had approved of Bell's Centennial award. Another member, less familiar with Bell's achievement, but casting about for some amiable comment, suggested that 'such an instrument, when perfected, might be used in analysing linguistic sounds.'

The Washington *Evening Star*, a week later, described the occasion at length, and — back in Boston — Alexander Graham Bell cut the item out, dated it, and pasted it carefully in his scrapbook. He was already arranging with the Eastern Railroad Company for another Sunday test, which was duly noticed in all the Boston papers. The *Globe* headed its account, 'Talking by Telegraph.' The *Advertiser* added this paragraph:

> Recently two Japanese gentlemen conversed in their own language through the telephones, and had no difficulty in understanding all that they said. An experiment has been made in overcoming an artificial resistance greater than the Atlantic cable, and there is no doubt but that it will be possible to talk across the Atlantic.

The Japanese gentlemen were Bell's pupils.

He was still sure that he would be able to talk across the Atlantic!

On the last day of January, there was still another trial of the telephone, made on a private telegraph line running from the offices of the Boston Rubber Shoe Company on Congress Street to the house of Mr. Converse, in Malden. The *Transcript* ran a news account of this test and commented editorially upon it. A few days afterward the *Scientific American Supplement* published an article on Bell's invention entitled 'Bell's Articulating Telephone,' derived from an English journal of the previous December. Bell saved every cutting. His scrapbook was taking on sizable proportions now.

(2)

All of this time Bell's means were as narrow as ever, and the fees of patent solicitors, the bills for material from Williams' shop, Watson's wages, and his and Bell's travelling expenses were being met largely by Mr. Sanders, who is said to have advanced nine tenths of all the expenses of Bell's work up to 1878. Bell wanted to reimburse him, and wanted to get married.

Bell's patents were now offered to the Western Union Telegraph Company for one hundred thousand dollars.

Gardiner Greene Hubbard had lately been an appointee of the Grant Administration as chairman of a special commission to investigate the question of railway mail transportation. He had taken a zealous interest in a proposed postal telegraph system, and his recommendations had not endeared him to the Western Union Telegraph Company.

Bell used to say that he had made this offer of his

patents in person, and that he had been shown out of the company's office when it was learned that Mr. Hubbard was one of his backers. No evidence to support or to disprove this has been available to the writer. Bell, for all his essential honesty, had too much appreciation of histrionic effect to spoil a good story, and in his later years accepted and repeated many an apocryphal anecdote which he would have instantly rejected as evidence. The old tale of Dom Pedro's 'My God, *it talks!*' at the Centennial — the invention of some fertile brain after the event — was one of these. Another was the story of Bell's impetuous boarding of the moving train for Philadelphia on that occasion — without ticket or luggage — at the sight of Mabel Hubbard's tears. Bell had his bag and his ticket for that departure; Mabel Hubbard was not on the train; and she did not weep.

It may be that the story of Bell's abrupt dismissal by the Western Union is one of these bright balloons of fancy. It may be that the circumstances relate to another interview. But every one with a proper sense of good theatre must hope that it really happened.

At all events, the offer was made, and declined. 'What use could this company make of an electrical toy?' is the comment credited to Mr. Orton.

Everybody in the Bell group was bitterly disappointed. A few years later, the Western Union company would have been glad to pay twenty-five millions for the patents which Bell and his friends were then so eager to sell for a hundred thousand dollars.

Mrs. Hubbard still favoured Bell's suit for her

daughter's hand. The young people had been engaged for over a year, but their marriage — depending upon Bell's finances — seemed as remote as ever. Mrs. Hubbard now suggested that to bring immediate returns some thousands of telephones should be manufactured and sold outright for cash, a plan that very nearly went through. If it had gone through, it would have lost to the telephone's promoters the profits that came later from a policy of leasing instead of selling the instruments outright.

Instead, a sudden demand for popular lectures on the telephone averted this innocent blunder. The interest aroused through the Centennial exhibit and Sir William Thomson's commendation, the appearance in an American journal of the flattering English comment that followed upon Sir William's Glasgow address, and now the frequent newspaper notices of Bell's long-distance tests, had their cumulative effect. Bell was asked to address the Essex Institute of Salem, in Salem's Lyceum Hall, on the 12th of February.

(3)

The Exeter Place workshop was connected with the wires of the Atlantic & Pacific Telegraph Company, and a line was run from the telegraph company's office to the Lyceum Hall. There a wire dangled from the gas chandelier to the big box telephone on the platform table. Looking very tall and very thin in his Prince Albert coat, Mr. Bell was introduced. He bowed to the chairman, to the audience; 'Mr. Chairman,' he began, 'ladies and gentlemen . . .' He had a naturally musical, reso-

nant voice, and he knew what to do with it. After all, Bell was a teacher of elocution and of platform speaking. He could have made a lecturing success of a subject far less spectacular. He described the mechanism of his invention in simple language, and then — with full appreciation of the dramatic pause — bent down to the mouthpiece of the box telephone, and with great distinctness said, 'Mr. Watson, will you speak to the audience?'

Upon this signal, Watson, who had been waiting for it at Exeter Place, crowded his lips into the transmitter, and, with all the power of his vigorous young lungs, hurled across the miles, 'Ladies and gentlemen — It gives me great pleasure to be able to address you this evening, although I am in Boston, and you in Salem!'

A little blurred, but distinguishable, the phrases burst upon the Salem audience. The members of the Essex Institute burst into laughter, hand-clapping and applause. (Mabel Hubbard sat in heart-breaking suspense at one of these early lectures, saw all the laughter and commotion and, unable to hear, thought the audience was 'laughing *at* him.') Members in the back rows bobbed up in their seats to make sure that nothing was being concealed by the plumed bonnets of the ladies in front. Members in the front rows could actually make out the words!

'About twenty persons listened in the little room at Exeter Place, 'up three flights of stairs,' the newspapers said, including 'three gentlemen from one of Dr. Tourjée's Tabernacle choirs, a cornet player, and an artist illustrating the scene for the *Scientific*

American, besides reporters from the various city papers.' They heard Bell singing 'Yankee Doodle' and 'Auld Lang Syne' from Salem.

A despatch was sent from Salem to the Boston *Globe* and appeared next day, February 13, 1877, with the lead, 'Sent by telephone — the first newspaper despatch sent by a human voice over the wires': 'We have the pleasure of presenting to our readers this morning the first despatch ever sent to a newspaper by the newly invented telephone, Prof. A. Graham Bell's system of transmitting sound by telegraph. . . .'

The lecture was a sensation. Salem talked of nothing else, and two days later an invitation to repeat it was sent to Bell, signed by sixteen prominent citizens of Salem, and phrased with that leisured punctilio which his invention was to abolish.

Prof. A. Graham Bell

DEAR SIR —

A general desire has been expressed among our citizens, that you should repeat the very interesting and instructive lecture of Monday evening last on Telephony, and we shall be pleased if your occupations will allow you to comply with this invitation, to devote another evening in Salem to experiments with the telephone, at such time as you may designate.

Meantime resolutions of cordial thanks were adopted by the Essex Institute and copies forwarded to Messrs. Bell and Watson.

Nine days later, Mr. Bell's occupations allowed him to repeat the lecture and demonstrations, and the ceilings of Exeter Place shook to the lusty re-

verberations of young Mr. Watson talking sixteen miles to Salem.

There were five hundred people in the Lyceum Hall. A contemporary account, in *Frank Leslie's Illustrated Newspaper*, said:

Professor A. Graham Bell gave a lecture about the telephone in Salem, and to illustrate its working capacity he had the operator in Boston give the audience the news from Washington. Every word was heard all over the hall, and the spectators were so astonished that they broke into applause, and, what is marvelous, the applause was heard in the Boston office, eighteen miles distant. The news came fleeting along that the engineers of the Boston and Maine Railroad had 'struck.' General Cogswell asked if trains were running; the answer was clear and distinct that they were not at half-past five o'clock. Professor Bell introduced the Rev. E. C. Bolles, who said, 'I shake hands with you cordially in imagination twenty miles away.' The Rev. E. S. Atwood asked, 'Does it rain?' 'It does not in Boston,' was Mr. Watson's answer. One of the assistants in Boston then said that 'Hold the Fort' would be sung in Boston, and the tune which followed was readily recognized.

The net proceeds of this lecture were eighty-five dollars. It was the first money that the telephone had ever earned. And, needing it acutely for rent and clothes and food, Bell spent the whole of it on a little silver model of the instrument to give to Mabel Hubbard.

(4)

Soon after his first Salem lecture, Bell received the following letter from Professor Dolbear, of Tufts College:

College Hill, Mass., *Feb.* 16

Prof. A. G. Bell

Dear Sir, —

The other day I visited your room at Exeter Place, and was kindly shown your invention, the Telephone, by Mr. Watson. He mentioned having sent messages through three persons holding hands, but didn't know the resistance of such a circuit. I promised to measure the resistance of the human body in a circuit and send to you, as he thought it would be useful, and gave to me one of your envelopes.

The following is my result, deduced from measures of eight persons:

Resistance in Ohms, an Average of 8 individuals:

From one hand to the other through the body hands dry	10,000+
" " " " " " " " " hands wet	6,000
From mouth to hand, latter dry....................	8,000
" " " " " wet....................	5,000

You will notice that I put them all in *round* numbers, but the experiments justify it. There was a wonderful difference in individuals, which surprised me at first. One person having a resistance upwards of 40,000 ohms. I perceived that the reason was the difference in thickness and horniness of the inner skin of the hands. Hence I conclude that you sent your message through a resistance of at least 18,000 ohms, nearly equal to the resistance of 2000 miles of ordinary telegraph wire. I congratulate you, sir, upon your very great invention, and I hope to see it supplant all forms of existing telegraphs, and that you will be successful in obtaining the wealth and honor which is your due.

Yours truly

A. E. Dolbear

(5)

The Salem lectures were widely noticed in newspapers throughout New England and in New York

City. The notices were copied in England and in Canada, but the Chicago *Tribune* for February 16 ran a contemptuous paragraph on these news accounts, dwelling on the 'spurious claims of Professor Bell' and referring to Elisha Gray as the 'real inventor of the telephone':

> Many of the Eastern newspapers are favoring their readers with sketches of Professor A. M. [A. G.] Bell, 'the inventor of the telephone.' Meanwhile, the real inventor of the telephone — Mr. Elisha Gray, of Chicago — minds his own business, and apparently concerns himself not at all with the spurious claims of Professor Bell. Persons acquainted with the subject need not be informed that Mr. Gray's claims are incontrovertible. Science long since recognized them. They were established in the columns of the *Tribune* years ago, before Professor Bell was so much as heard of. They are officially approved in the Patent Office at Washington, and they have already brought in large returns in money as well as in reputation to the inventor. Talking by telegraph and other sport of that description Mr. Gray has not paid much attention to as yet, because there is no present indication in it of anything more than sport; but the principles involved in it were discussed by him and have all been used by him in a practical manner.

The principle of the electric speaking telephone, Bell's 'great and happy conception' of the undulating current, was then so imperfectly understood that this paragraph was penned — obviously — on the mistaken assumption that the device with which Professor Bell was delighting Salem audiences was the harmonic or multiple telegraph, to which Gray's claim was as good as Bell's. (Unfortunately, the terms 'telephone' and 'telegraph' were used interchangeably at the time.) It did Gray an injustice,

since he had never claimed to have duplicated Bell's work with the speaking telephone, and had never developed the ideas which his Patent Office caveat outlined, but its result was to precipitate an exchange of letters between Gray and Bell which was profoundly to influence telephone history.

Bell had seen the Chicago *Tribune's* attack and was still furiously angry when he received the following letter from Elisha Gray:

CHICAGO, *Feb.* 21, 1877

Prof. A. G. Bell:

MY DEAR SIR:

I give a lecture in McCormick Hall, this city, Tuesday evening, the 27th inst., on the *telephone*, as I have developed it. I also connect with Milwaukee, and have tunes and telegraphing done from there. I should like to explain and exhibit *your* method of transmitting vocal sounds as well, but do not feel at liberty to do *more* without permission from you. I should explain it as *your* method, and not mine, although the *Office* records show a description of the talking telegraph filed by me the *same* day yours was filed. The description is substantially the same as yours. I was unfortunate in being an hour or two behind you. There is no evidence that either knew that the other was working in this direction.

With our facilities I can get up an apparatus on a day's notice that will answer. I have a copy of your last patent. Please telegraph at my expense, on receipt of this, yes or no, and I will act accordingly.

Yours truly

ELISHA GRAY

220 Kinzie St., Chicago

I send this care Mr. Hayes, as I do not know your address. I received a line from you through Mr. Baldwin, for which please accept thanks.

Bell received this on the 24th. Feeling bitterly the injustice of the Chicago *Tribune's* paragraph, he sent a stinging telegram to Gray. He was in no mood for a message at Gray's expense. He prepaid it.

BOSTON, *February* 24, 1877

Elisha Gray
Western Electric Manufact. Co.

If you refute in your lecture, and in the Chicago *Tribune*, the libel upon me published in that paper February sixteenth, I shall have no objection. Please answer.
A. GRAHAM BELL

Gray replied the same day, with only a little less heat:

CHICAGO, *Feb.* 24, 1877

Prof. A. G. Bell

SIR:
Your telegram received. In answer, I would say, first, that I do not know what article you refer to, but will see the paper of that date. I have seen one or two articles lately that ventured to assume that you were not the only man in the world who had contributed to the development of the telephone. If such assertions are '*libels*,' then you have been *libelled*. So far as I know, the 'libels' are mostly on the other side, if assertions of *originality*, etc., may be so considered. The papers here have been full of articles of late, copied from Boston papers, claiming the whole development of the telephone for you. It would not be strange if some one, knowing the facts, should speak, and in doing so may have done you injustice.

You seem to assume that I am responsible for all the newspaper articles that are not in your favor. I assert here that I have never said a word about you in the public prints, and I have always — even to the degree of offending some of my friends — defended you when I have heard disparaging remarks made about you. Since I

made your acquaintance I have taken the ground that we were both independent inventors. Now, if we are going into the refutation business, I suggest that it be mutual. So far as I know there is quite as much needed from your side as from mine. I am always willing to correct any wrong done you, even if I am not responsible. If we undertake to follow up the newspapers we will have our hands full. I shall not show your apparatus, as I do not want any conditions imposed until I know what I am expected to refute. I do not know but that it is to deny all claim to the invention. Allow me to suggest that your telegram was just a little indiscreet, as it contained an assumption very unjust to me.

I do not know your address, so I send through Mr. Hayes.

Yours truly

E. GRAY

P.S. You should have sent your dispatch collect, as I requested it sent.

Presumably this letter reached Bell on or about the 27th. It found him busy with the examination papers of his normal class, and he did not reply until the 2d of March, the eve of his birthday. Then he wrote:

BOSTON UNIVERSITY, *March* 2, 1877

Elisha Gray, Esq., Chicago

MY DEAR SIR:

I was somewhat hasty, I must confess, in sending my telegram, for, of course, you are not responsible for all the ill-natured remarks that may appear in the newspapers concerning me.

I am sorry that my telegram should have prevented you from making the experiments you desired, for it is my sincere desire to oblige you in any way I can. I am glad that you are willing to do me justice, and must thank you for saying a good word for me occasionally. I may say

that it has uniformly been my custom to make honourable mention of your name in multiple telegraphy, and to give you the credit of being an independent inventor.

I have not generally alluded to your name in connection with the invention of the electric 'telephone,' for we seem to attach different significations to the word. I apply the term only to an apparatus for transmitting the voice (which meaning is strictly in accordance with the derivation of the word), whereas you seem to use the term as expressive of any apparatus for the transmission of *musical* tones by the electric current.

I have no knowledge of any apparatus constructed by you for the purpose of transmitting vocal sounds, and I trust that I have not been doing you an injustice. It is my sincere desire to give you all the credit that I feel justly belongs to you.

I do not know the nature of the application for a caveat, to which you have referred as having been filed two hours after my application for a patent, excepting that it had something to do with the vibration of a wire in water, and therefore conflicted with my patent. My specification had been prepared *months* before it was filed, and a copy had been taken to England by a friend. I delayed the filing of the American patent until I could hear from him. At last the protests of all those interested in my invention, deprecating further delay, had their effects, and I filed my application without waiting for a conclusion of negotiations in England. It was certainly a most striking coincidence that our applications should have been filed on the same day.

I have been kept so busy during the past few days correcting the examination papers of my normal school, that I have been unable to write.

In haste
Yours truly
ALEXANDER GRAHAM BELL

There is a forthright tone about the letters of Bell and Gray in this exchange that would seem to have

been impossible had either man written with legal oversight. They have an unrestraint alike in Bell's angry telegram and in his manly apology for the injustice it implied to Gray. Gray's response was in kind:

CHICAGO, *March* 5, 1877

Prof. Bell

MY DEAR SIR:

I have just received yours of the 2nd instant, and I freely forgive you for any feeling your telegram aroused. I found the article I suppose you referred to in the personal column of the *Tribune*, and am free to say it does you injustice.

I gave you full credit for the talking feature of the telephone, as you may have seen in the Associated Press dispatch that was sent to all the papers in the country — in my lecture in McCormick Hall, Feb. 27th. There were four different papers represented at the lecture, but only one — the *Tribune* — alluded to my mention of you, except the 'Press' dispatch. I described your apparatus at length by diagram.

Of course you have had no means of knowing what I had done in the matter of transmitting vocal sounds. When, however, you see the specification, you will see that the fundamental principles are contained therein. I do not, however, claim even the credit of inventing it, as I do not believe a mere description of an idea that has never been *reduced* to *practice* — in the *strict sense* of that phrase — should be dignified with the name invention.

Yours very truly

ELISHA GRAY

It was a fair and straightforward letter. Gray had had very much the same idea, but he had never reduced it to practice. He did not claim to have invented the telephone, and he said so: clearly this man was not responsible for the *Tribune's* paragraph.

'If we undertake to follow up the newspapers we will have our hands full,' he wrote. He was right. Bell tossed the letter aside. (Long afterward it was pointed out to Gray that he had been imprudent in writing this letter. 'It was right,' he is quoted by his attorney, 'it would come out sooner or later, and I prefer to have it come out in this way.')

Bell was in New York, arranging for a long-distance test of the telephone to Boston, when — on April 2d — Mr. Elisha Gray gave a public demonstration of his harmonic telegraph. This was advertised as a 'Telephone Concert,' for the transmission of music by telegraph. Bell went.

In reporting the concert the New York *Tribune* said:

> After the first part of the programme had been executed, Mr. Elisha Gray came forward and addressed the audience. He was aware that great confusion existed in the popular mind as to what this telephone could perform; in particular it had been confounded with the speaking telephone invented by Professor A. Graham Bell, of Boston. Professor Bell, Mr. Gray said, was present in the audience.

In this graceful gesture Gray publicly buried the hatchet. The *Daily Graphic* added: 'Professor Gray's invention is applicable alone to the transmission of instrumental music. Professor Bell of Boston is the inventor of the apparatus for transmitting the tones of the voice. The two inventors are very good friends.' Professor Bell was present, the *Graphic* added later, applauding vigorously.

(6)

Bell, at Gray's lecture that evening, was waiting for midnight, when a wire of the Atlantic and Pacific Telegraph Company would be free and he could connect up his telephone. In the little attic room in Boston, Watson was far from happy. He knew that the fearful din he was going to make would shatter sleep for the lodgers of Exeter Place.

'Having vividly in my mind the strained relations still existing with our landlady,' Watson says, 'and realizing the power of my voice when I really let it go, as I knew I should have to that night, I cast about for some device to deaden the noise. Time was short and appliances scarce, so the best I could do was to take the blankets off our beds and arrange them in a loose tunnel on the floor, with the telephone tied up in one end and a barrel hoop in the other end to facilitate my access to the mouthpiece.'

He waited for the signal by telegraph which notified him that Bell was ready in New York. Then he connected the telephone, 'crawled into the blankets, and shouted and listened for an hour or two.' He could hear Bell's voice, but not very clearly, and his own blanketed remarks did not seem to be understood with any distinctness in New York. It was the first attempt to talk between New York and Boston, but years of research and experiment intervened before improved circuits replaced the existing telegraph lines with their high resistance and rusty joints over which this first conversation was essayed. Watson was very glad to find that Bell thought the results too feeble to impress his New York audience. One experience of broadcasting from that suffocat-

ing embrace was enough for even Watson's enthusiasm. Nevertheless, he was gratified to find that his sound-proof booth was a complete success so far as his fellow lodgers were concerned. Anxious enquiry the next day proved that even the occupant of the room below, chief sufferer from their tumult, had slept undisturbed. 'Later inventors improved the booth,' Watson says, 'making it more comfortable for the public to enter, but not a bit more soundproof.'

A despatch to the Boston *Globe*, published on April 5, read:

> New York, *April* 4: Professor A. Graham Bell made an experiment with his telephone, over the Atlantic and Pacific Telegraph Company's wires, between Boston and New York last night; the Professor, who was in this city, communicating with his assistants in Boston. The experiment was a great success. Everything said by the Professor's assistants was plainly heard by those in attendance here, the conversation being carried on at the ordinary rate of talking.

This is a beautiful example of Bell's formal manner with the newspapers. Watson might be waking all the lodgers in Exeter Place, but for purposes of publicity he was an implied staff of Watson. And Bell, anxiously listening for a faint 'Ahoy,' was 'communicating with his assistants in Boston.' Honest man though he was, he was not his father's son for nothing. Public faith in his telephone meant needed capital to Bell. And, better than most men, he appreciated the value of those upward and outward gestures of manner as of elocution that expressed confidence and dispelled doubt.

(7)

It was the day after this exploit that Watson strung the first commercial telephone line, from Charles Williams' shop in Boston, three miles, to his house in Somerville. The occasion was the first of the formal openings of telephone lines. The inventor, Professor Bell, and his assistant, Mr. Watson, were there; reporters had been invited, and Mrs. Williams gave them such a luncheon in honour of the occasion that Watson remembers it yet. The Boston *Globe* commented the next morning:

PERFECTING THE TELEPHONE

Professor A. Graham Bell, the inventor of the telephone, had the pleasure of assisting yesterday at the opening of the first regular telephonic line in the world — a private line between the place of business of a gentleman in this city and his residence in Somerville. The instruments worked admirably, and the enterprising gentleman is very much pleased with his private telephonic wire between town and home. The practical value of Professor Bell's invention is being newly proved every day.

The day after the opening of the Williams line Bell gave the second of the public lectures on the telephone, in the Music Hall at Providence, Rhode Island.

Near the platform, at this lecture, a telegraph pole had been put up, and telephones were placed at several points around the hall, all of them connected to the big box telephone on the stage. The preparations excited all of Providence. The hall was filled. 'I should think there must have been a couple of thousand people there,' Bell said. Watson, of course,

was in the Exeter Place room, in charge of the broadcasting. In some of the later lectures he engaged a small brass band, but for the Providence performance solo musical effects were still thought sufficiently startling.

'During the first part of his lectures Bell gave his audience the commonplace parts of the show, organ playing, cornet music, brass band, etc., and then came the thrillers of the evening — my shouts and songs.' Moody and Sankey had been a year or two in the country and from their meetings Watson had picked up two ringing revival songs, 'Pull for the Shore,' and 'Hold the Fort.' These, with the only other songs he knew, 'Yankee Doodle,' 'Auld Lang Syne,' and the plaintive counsel of 'The Gypsy's Warning,' were the climax of the performance. Watson is modest about these musical feats and says that they were called 'by courtesy,' singing. Nevertheless, 'the telephone,' he says, 'obscured its defects and gave it a mystic touch. After each of my songs I would listen at my telephone for further directions from the lecturer and always felt the thrill of the artist when I heard the applause that showed me how much the audience appreciated my efforts. It was usually encored to the limit of my repertory.'

(8)

The day after this Providence lecture a flattering invitation was sent to Bell from a group of prominent citizens of New York:

NEW YORK, *April* 7, 1877

Professor A. Graham Bell
Boston University

DEAR SIR

The interest excited during the Centennial Exhibition by your experiments with your Telephone, holding communication in audible speech with persons many miles away, and the published accounts of your improvements in the wonderful instrument, prompt us to request that you will deliver in our city, on some evening convenient to yourself, a lecture on Sound and Electricity, with an exhibition of your Speaking Telephone, showing what can be done by it and making known its Scientific and Commercial value.

Very truly, &c

F. A. P. BARNARD (*President of Columbia College*)

HOWARD CROSBY (*Chancellor of New York University*)

HENRY MORTON (*Stevens Scientific School*)

E. L. YOUMANS (*Editor of Popular Science Monthly*)

CYRUS W. FIELD (*Atlantic Cable*)

THOS. T. ECKERT
(*President of Atlantic and Pacific Telegraph Company*)

A. M. MAYER (*Stevens Scientific School*)

WILLIAM ORTON
(*President of Western Union Telegraph Company*)

J. S. NEWBERRY (*School of Mines, Columbia College*)

C. F. CHANDLER
(*Professor of Chemistry, College of Physicians and Surgeons*)

H. D. NOYES (*Professor of Aural Surgery, Bellevue College*)

JNO. W. DRAPER
(*Professor of Chemistry, New York University*)

A fortnight later the first citizens of Boston wrote to him as follows:

BOSTON
1877 *April 20th*

Professor Alexander Graham Bell

SIR:

The undersigned having followed with great interest the accounts of your discoveries and inventions in connection with the electric telephone, which have from time to time appeared in the newspapers, and confident that the general public of the city in which your researches have been made, will be glad to witness a practical exhibition of your telephone under your direction, respectfully request you to gratify this desire of your fellow citizens, at such time and place as may be most convenient to you.

BENJAMIN PEIRCE
JOSEPH LOVERING
E. N. HORSFORD
HENRY W. LONGFELLOW
GEO. B. EMERSON
O. W. HOLMES
CHARLES W. ELIOT
ALEXANDER H. RICE
NEHEMIAH GIBSON
FREDERICK O. PRINCE
WILLIAM F. WARREN
JOHN D. RUNKLE
C. F. ADAMS
WOLCOTT GIBBS
EDWARD C. PICKERING
LEWIS B. MONROE
(by A. G. B.)

Obviously there was now a prospect of a lecture tour with large immediate earnings. Bell, who was always helpless in business matters, took on as manager of his lectures a clever young newspaper man of Providence, Fred Gower.

(9)

In response to Boston's invitation, Bell gave three lectures in the Music Hall, in the First Week of May.

After the first of these he received another letter from Professor Dolbear:

College Hill, Mass., *May 6th*, 1877

Prof. A. G. Bell

My dear Sir, —

I listened with pleasure to your lecture at Music Hall, last Friday night, but as I understood you to say concerning the latest forms of the Telephone that you were without a competitor, I wish to acquaint you with my connection with this invention, and I hope you will patiently listen to me through a short story.

As long ago as *June, 1864*, while studying electricity at college and also employed by the prof. of Nat. Science to make some magnets both electro and permanent, I invented substantially this arrangement and described it to the prof., to the telegraph operator at the place, and endeavoured to interest some parties in it, so as to undertake the construction of working instruments. They were all skeptical, and as I had no funds or means beyond those for my college expenses, I had to abandon it. Last fall when reading the remarks of Sir W. Thomson concerning your invention, I at once thought of my former one, and at once began some experiments which resulted in this present form of the Telephone, such as you use; that is, the inducing permanent magnet and the vibrating plate. This was early in December last. I had not the slightest idea that you were at work on the same line. After I had succeeded in this, I thought of *visiting you and saying to you that what you were doing with a battery* could be as well done without a battery, but my friends persuaded me to keep away from you, to perfect a pair of instruments and obtain a patent for them; this I was doing when your invention of the same thing was made public. I have looked over the patent files and noted that your application dates Jan. 15th, and that the patent was granted on the 30th of that month. To me it appears that I had invented this form while you were yet experimenting with the battery, as for instance between Cambridgeport and Boston, Malden and B., &c.

There are plenty of persons here who know about these things and can testify that they all preceded any mention

of your experiments in the same direction. This, I think, entitles me to at least an equal claim with yourself to this latest form of the Telephone.

I did at one time seriously think of contesting your patent, but I learned that it was always a costly thing and I hadn't a cent to spend for any such purpose, therefore I beg you not to be uneasy in the slightest degree as to your claim.

I shall not interfere. All I would ask of you will be that while giving the work of others upon the subject, you will not entirely ignore me.

It is the commonest thing in the world for two or more persons to hit upon the same idea at the same time, without any knowledge of each other's work, and the history of telegraphy abounds in such incidents, as you know.

This is all I have to say about that matter, and if you will allow me to correct a statement I understood you to make concerning the effect of magnetization upon a piece of iron.

I understood you to say that when a piece of iron was magnetized that it was *shortened.*

It should be *lengthened.* Joule made its increase in length to be about 1/27000 of its own length. Mayer, in 1872, made it the 1/25000 for soft iron. In 1871, I also measured it, using a tilted beam of light 60 ft. long, and also made it 1/25000 of its length. For *hardened steel* I believe that it is shortened.

Now, my dear sir, I hope that you will not feel any way but kindly towards me, as I admire both your wonderful ingenuity and persistence, and I would love to count you as one of my friends.

I hope that you will yet be able to make the Telephone even to surpass the vision of the wild 'Graphic Man,' and that you will meet both Fame and Fortune.

Yours truly

A. E. Dolbear

Perhaps it seemed odd to Bell that three months earlier Professor Dolbear should have visited the

Exeter Place workshop to inspect the telephone, and later written to congratulate him upon its invention without speaking of his own work, but this letter seemed to him perfectly friendly and frank. He showed it to Mr. Hubbard just before his second appearance at the Music Hall and said that he was going to mention Dolbear's work in the course of his lecture. Promptly, Mr. Hubbard told him to do nothing of the sort. Did he know anything of Professor Dolbear's experiments? Bell knew what Professor Dolbear told him. Here was the letter. Mr. Hubbard dryly advised Bell to make sure of his facts before making public acknowledgement of any rival claim to the telephone.

(10)

The Boston lectures were repeated in Chickering Hall, New York, on the 17th, 18th, and 19th of the same month.

As a preliminary to these Bell gave a private demonstration of his invention at the St. Denis Hotel, for the gentlemen who had invited him to New York. They brought guests, and when the gathering swelled, unexpectedly, to fifty persons, Bell thought it well to elaborate his programme. He sent Gower to Brooklyn to talk. There was a long delay and when Gower finally got into communication with the St. Denis he explained that he had been hunting up a cornet player and had borrowed one from the orchestra of a neighbouring theatre. Asked where he was, Gower said 'Fulton Street.' Absently, Bell repeated it to the gathering 'Beacon Street,' at which 'loud roars of laughter ensued.'

At the first of these Chickering Hall lectures, after the usual demonstrations (this time coming from New Brunswick, New Jersey), concluding with 'Hold the Fort' 'sung by a strong baritone voice and plainly audible,' Mr. Cyrus W. Field joined Mr. Bell in asking a number of questions through the telephone. These were all answered 'satisfactorily,' said the New York *Times*, 'by those at the end of the wire in New Brunswick.' The *Daily Graphic* said that Mr. Field 'hollered,' and that Mr. Bell talked gently. In the audience were Mr. W. H. Preece and Mr. Wheeler, of the English Postal Telegraph Service.

That month the telephone was exhibited also at the American Institute Fair, upon Third Avenue near Sixty-Third Street. Of this Fair and Bell's exhibit *Valentine's Manual* says:

> Many of our old merchants still proudly display the gold medals and 'Certificates of Merit' awarded them as being the best ever in their respective lines. This fair was quite a venerable institution and gave yearly exhibitions. It has recently been revived. An old-time programme lying before me shows that Alexander Bell was exhibiting here a contrivance which he called a telephone and for the small sum of ten cents you were permitted to talk from one end of the hall to the other. I squandered a dime for this and remember holding a hollow thin disk to my ear and speaking through it and hearing a voice from the other end. It attracted no attention and was considered on a par with the dozen other insignificant catch-penny devices which invariably accompanied any public exhibition of this sort.

A front-page story in the New York *Evening Post* for May 16, however, noticed Mr. Bell and his telephone:

Another lecturer, Prof. A. Graham Bell, has just now drawn a crowd to listen to his history of the telephone and illustrate its marvellous power. Such men as the poets Longfellow and Holmes, President Eliot, Prof. Munroe and Charles Francis Adams being among the persons who are eager to have the workings of this instrument explained. . . . Prof. Bell is a most genial and kindly presence. So courteous and gracious in manner that you could not feel yourself an intruder though you chanced to drop into this room when some private class was under special training. At the same time, though his affability sets you at ease, you could not fail to observe that he is one of the busiest of men, so intent upon the development of his plans which occupy his life that he has no leisure for visitors who are not interested in his work. He is young, apparently not more than five and thirty [Bell was just thirty], with an unusually prepossessing countenance, very happy in its expression, of pale complexion, with jet black hair brushed up from his forehead and pleasant sparkling black eyes — the face of a man engaged in his work and finding satisfaction in it.

(11)

The widespread newspaper mention of the telephone and the weight of the names attached to the invitations to lecture in Boston and New York suggest the stir that Bell's invention was creating in 1877. Collected as evidence of Bell's then unchallenged claim to the speaking telephone, the newspaper paragraphs of that year made an impressive exhibit long afterward in the suits involving the Bell patents. It would be easy to assume from these that the world, already aware of the telephone's stupendous possibilities, was offering Bell generous recognition of his genius. Despite Sir William Thomson, the world was doing nothing of the sort. To the

general public the telephone was nothing more than the lecture fad of the moment — in a day when Americans went to lectures instead of to moving pictures. The first citizens of New York and Boston were interested in an evening's entertainment with an 'interesting scientific toy,' and the newspapers noted these events along with other curiosities in the world's news, with spectacular suicides and the use of blue-glass lamp chimneys 'to promote literature and digestion.

Fred Gower, as Bell's business manager, now planned more ambitious efforts than ever for the telephone lectures. Bell was to speak in one city, Gower in another, and each audience was to hear Watson's performance from a third and intermediate point. It was not a success. The night that Bell lectured at New Haven, and Gower at Hartford, they didn't talk about the same thing at the same time. 'The next morning,' says Watson, 'when I met Gower he was quite vexed and accused me of shouting "How do you do" when he wanted me to sing "Hold the Fort," and Bell said I made it very awkward for him when he wanted me to give him the trombone solo, by singing "Do not Trust Him, Gentle Lady." Gower said I did it on purpose, and Bell looked at me quizzically, but it wasn't so, I was too fond of Bell to play such a joke on him.'

(12)

That spring, Bell made an arrangement with Colonel Reynolds, of Providence, Rhode Island, to establish the telephone in England. On the glowing prospect of this trans-Atlantic venture he renewed

his suit at Brattle Street, and at last Mr. Hubbard gave in. The wedding was set for July. Expensive gilt clocks began to arrive from relatives, and seamstresses ran tucks by hand on Miss May's trousseau.

They were married on July 11, 1877. Watson and Eddy Wilson were invited. They went, and wore white kid gloves for the first time in their lives. And since they didn't know that they would have an opportunity to put them on at the house, and were too self-conscious to wear white gloves in the horsecar, they put them on behind a tree in the front yard before they went in. For his wedding gift Bell made over to his bride all his interest in the telephone! He used to recall that Mr. Hubbard smiled, tolerant of a young man's gesture.

They sailed for England in early August. But first Bell took his bride to his parents' house in Canada, and as she came to the threshold Aleck's mother ran out to break oatcake over her daughter-in-law's head, in the Scottish tradition. Now she would never go hungry in her husband's house!

CHAPTER XIII

(1)

WITH his young wife Bell remained abroad for eighteen months. Their first child, a daughter, was born before they returned to America. Released in a measure from the uncertainties and strain of his Boston years, Bell expanded in his new fame and his new happiness, and, with the generous acclaim of English scientists, this interlude brought him, initially, the greatest professional and personal triumphs of his life.

Up on the Scottish coast near Elgin, the pair found the little fishing hamlet of Covesea, and a fisherman's cottage on the outskirts, in which the romantic and unpractical Bell thought it would be delightful to spend part of their honeymoon. He persuaded the occupants to take them in and, for a week, they wandered about the wild coast country, living in idyllic discomfort, subsisting principally on a diet of fish and oatmeal. After a week of it, Mabel Bell began to wonder, audibly, whether they couldn't have something else to eat, and her contrite husband strode off five miles to the nearest town to buy her something more palatable. It is a typical picture. Presumably he could have waited and got a conveyance. But Bell never waited when he wanted to do anything.

(2)

In England that August, the announcement of a paper on the telephone by Mr. William Henry

THE OLD KITE HOUSE, BEINN BHREAGH
Later the 'Museum,' on the hillside where Bell flew his giant kites

THE KITE CYGNET I ON BOARD ITS TENDER UNDER WAY FOR THE TRIAL IN WHICH IT SOARED 168 FEET ABOVE BADDECK BAY CARRYING LIEUTENANT SELFRIDGE
Lieutenant Selfridge is sitting at left. December, 1907

AERIAL EXPERIMENT ASSOCIATION DROME NO. 4,
MCCURDY'S SILVER DART

Flying over the ice of Baddeck Bay, February, 1909, with J. A. D. McCurdy as aviator

BELL'S OIONOS

A triplane using tetrahedral cells, a compromise with lifting surfaces. March, 1910, at Beinn Bhreagh

Preece was creating a sensation at the meeting of the British Association at Plymouth. An invitation was telegraphed to Bell, then in Glasgow.

Professor Silvanus P. Thompson was reading a paper on binaural audition; Mr. Francis Galton, one on his researches in hereditary traits of criminals. Sir William Thomson spoke on the mariner's compass, and Mr. W. H. Barlow, a Fellow of the Royal Society, made a contribution on 'The Upward Jets of Niagara,' which he had deduced from the joggling of his bedroom windows when visiting Niagara the year before. It was an aggregation of the best types of scientific men in England, and their applause of Mr. Preece's paper 'On the Telephone' was an auspicious introduction for the young inventor.

Bell said, long afterward: 'I went down. I had one telephone in the hall and another about a mile away with a man in charge. When I had delivered my address, I invited any one to come up to the platform and talk to this man.

'There was a call for Lord Kelvin (Sir William Thomson), and when he mounted the platform there was dead silence. Every one was anxious to hear the words of wisdom that would fall from the lips of the great scientist.

'He was silent for a minute, and then he cried, "Hi diddle, diddle, the cat and the fiddle; follow that up!"

'Then he placed the telephone to his ear. Next, addressing the audience, he remarked, "There he goes, he says the cow jumped over the moon."'

There was much merriment over this, and after

the meeting Bell asked his helper whether he had heard Sir William clearly. 'I did not hear him at all,' was the reply. 'Then what did you say in reply to him?' Bell asked. 'I said, "Please repeat."'

The *Popular Science Review* reported:

> During the recent session of the British Association at Plymouth, the lion's share of attention was unquestionably given to the telephone. Wherever the instrument was to be exhibited, whether in the physical or mathematical sections, or at Mr. Preece's popular lectures, there were always crowded audiences, eager to learn something about so novel an apparatus . . . the interest in this subject culminated on the arrival of Professor Graham Bell, the inventor of the talking telegraph.

Nevertheless much work remained to be done with Bell's infant invention. The telephone current was still so weak and so sensitive to neighbouring currents that its feeble effects were often obliterated when operating near working telegraph wires. Its first, faint, thrilling 'Are you there?' was only too apt to be succeeded by a storm of whistling and sputtering sounds from an interfering wire somewhere close by, comparable to the static of the present-day radio. Bell began to work on the problem of overcoming this difficulty. It was finally remedied by using two conductors instead of one, and by so arranging them in relation to the disturbing wires that the currents induced in one of the telephone conductors was exactly equal and opposite to those induced in the other. 'In this way,' Bell said, 'an induction balance was produced and a quiet circuit secured for telephonic purposes. This method was patented in England in November, 1877, and during the whole

winter of 1877–78 I was engaged in London upon experiments relating to the subject.'

At the end of October a special general meeting of the Society of Telegraph Engineers was convened in London for the purpose of welcoming Professor Graham Bell to England. It was a demonstration of the most flattering and cordial kind, in a 'hall crowded to overflowing,' at a meeting said to be the largest ever held by the Society. The great Professor Tyndall was there; so was Dr. Hugo Müller, and a score of other great men. Upon the auspicious introduction of Sir William Thomson, Mr. Preece, and the British Association, the telegraph engineers of England were roused to the keenest enthusiasm over the invention of this young teacher who was neither an electrician nor an engineer. The London paper which had earlier dismissed the telephone as 'the latest American humbug' now headed its paragraph of description 'A Great Invention.'

These were busy days for Alexander Graham Bell. In addition to his experimental work in induction he rushed about Great Britain superintending the preliminary tests which were to interest English capital in his invention, and lecturing — parenthetically — on the education of deaf children. Speech was sent from England to Jersey, from Dublin to Holyhead, and from Dover to Calais. By cable and telegraph wires he proved the practicability of sending speech long distances; he talked with colliers at the bottom of coal pits and with a diver down in a tank. In this last experiment, 'He heard every word I said,' Bell stated triumphantly, 'and I was able to understand every word he said; and when I

told him to come up, by word of mouth, he obeyed me!'

The young Bells soon went to housekeeping in Kensington and great names in the English world of science were announced in Mabel Bell's little drawing-room. The guests were charmed with the wife's young beauty and delighted with the indefatigable and engaging husband who sat at the piano and sang 'Comin' thro the Rye' into the telephone for their entertainment. Mabel Bell wrote her husband's letters, translated German papers on sound for his information, and, reading his lips, took down in long-hand the dictations which were to become a lifelong habit.

(3)

Abroad, England had two minor wars on her hands, one with Afghanistan and one in South Africa with the Zulus. Russia was at war with Turkey, and while the English public was roused by rumours of Turkish atrocities in Bulgaria, Disraeli, backed by the Queen, held grimly to his policy of distrusting Russia no matter whom Turkey massacred. The adherents of the dawning æsthetic movement affected the languor, eccentricities and extravagances of dress and speech which Gilbert and Sullivan lampooned a few years later in 'Patience,' in which young ladies in draperies affected Burne-Jones attitudes, and fashionable young men walked about with sunflowers in their hands, in admiring imitation of Oscar Wilde.

Late in November, the Society of Arts invited Bell to address its members on the telephone, and the crush of the Telegraph Engineers' meeting was

repeated. Hundreds of persons were unable to get into the hall, and Bell was asked to repeat his address at a later date. When he did, the *Journal* of the Society begged those members who had heard the first lecture to 'refrain from exercising their privilege on the second occasion.' No one seems to have paid any attention to this entreaty, and when the meeting opened, Bell was presented to an applauding audience of twelve hundred persons. Throngs were 'unable even to enter the building.'

That week the Queen, accompanied by Princess Beatrice, travelled down to High Wycombe to lunch with Disraeli at Hughenden, and, departing, planted a tree on the lawn. England rocked with the news of this new favour to the Prime Minister. It 'created a powerful impression on the Continent.' Lampooning the incident, Mr. Punch also gave space to 'The Coming Agony,' a conjecture of the coming telephone service, forecasting the 'new District Telephone Office' with its Persian carpet, its buhl table with a copy of 'Elegant Extracts' and its cultured official and staff. There is no hint that *Punch* recognized the relationship between the grandfather's textbook and the grandson's invention.

The final marvel came when the telephone was exhibited at the Crystal Palace on Boxing Day (the day after Christmas), and, as a contemporary newspaper put it, 'a day when as everybody knows the Palace is crowded with more or less noisy persons.' Over the heads of the fifty thousand noisy ones a quarter of a mile of wire connected two telephones and to the amazement of every one the speeches exchanged were unaffected by the din.

(4)

While the telephone was still on its first wave of popularity, Colonel Reynolds had astutely enlisted the talents of Miss Kate Field to keep public interest from an ebb.

Miss Field, that dashing and beautiful lady, at forty was at the height of her reputation and charms. An American, she had become famous at twenty for her sprightly descriptions of Charles Dickens' Boston readings and as the author of 'Planchette's Diary.' She had lived in Italy, become an intimate of the Brownings, and later launched herself in a career of journalism despite the protests of relatives who would gladly have subscribed to a fund for her support if she would only behave like a lady and stop writing for the newspapers. In London in 1878 she was writing for the London *Times*, contributing to *Truth*, interviewing literary lions, and sending letters across the Atlantic to James Gordon Bennett's New York *Herald*. She went everywhere and knew every one. She was just the person to keep the telephone uppermost in the public mind.

In her diary of January 7, Kate Field wrote:

> I have already written twenty-one articles on the telephone and inspired others. My idea is now to invite the Press to a Matinée Telephonique, and get one general chorus of gratuitous advertising before the opening of Parliament, when everything will go to the wall.

That week Labouchere, of *Truth*, told Nash, the solicitor, that the telephone was splendidly managed; that he had watched the way the subject was kept before the public without in any way having

the suspicion of advertising. The comment, repeated to her, elated Miss Field, as well it might.

Certainly the telephone was the talk of the town. Among *Punch's* list of New Year's resolutions were these:

> To make calls.
> To make an effort to get up earlier in the morning.
> To make myself thoroughly acquainted with the Eastern Question in all its bearings, the relations between Capital and Labour, the principle and construction of the telephone . . .

In January its flattered inventor was commanded to demonstrate its wonders to the Queen. Her Majesty was at Osborne. Bell and Reynolds travelled to Cowes and so did Miss Field — accompanied by a lady companion, doubtless to preserve the proprieties. The gentlemen were presented to the Queen in the chilly council room at Osborne House, where Bell explained the apparatus, demonstrating its construction by means of an instrument sawn in two lengthwise. Miss Field, at Osborne Cottage, 'all fine' in her new blue gown embroidered with rosebuds, wearing Robert Browning's locket and chain, sang 'Kathleen Mavourneen' into the Royal ear. Miss Field had packed the new blue gown in expectation of an audience with Her Majesty, and one cannot but share her evident disappointment that when she went later to Osborne House she was received only by the Duke of Connaught. Presumably Her Majesty did not receive lady journalists, were they ever so charming.

The London *Times* described the event on January 16 with the lead 'The Telephone at Court':

1878: *Jan.* 16: On Monday evening, as announced in the Court Circular, Professor Bell and Colonel Reynolds were presented to the Queen, and exhibited the telephone, being assisted by Mr. C. Wolleston. In a lecture of fifteen minutes' duration Professor Bell explained the mechanism of his invention, and then held telephonic communication with Osborne Cottage, the residence of Sir Thomas Biddulph. The apparatus there was under the management of Mr. F. C. Ormiston, who was the first to address the Royal party. Her Majesty conversed with Sir Thomas and Lady Biddulph, and later Miss Kate Field, who was at Osborne Cottage sang 'Kathleen Mavourneen,' for which Her Majesty returned gracious thanks telephonically through the Duke of Connaught.

Miss Field afterwards sang Shakespeare's 'Cuckoo Song' and 'Comin' Thro the Rye,' and delivered the epilogue to 'As You Like it,' all of which was heard distinctly. The applause which followed came through the telephone. The Princess Beatrice, the Hon. Mrs. Ponsonby, and others, conversed with Osborne Cottage, sometimes through a circuit of one, three and five persons.

As the evening wore on, telephonic connection was established between Osborne House and Cowes, Southampton and London. At Cowes, where Major Webber, of the Royal Engineers, superintended the line, a quartet of tonic sol-fa singers, consisting of Miss Webber, Miss Strohmenger, Mr. Hamilton, and Mr. Curwen, sang several part songs, which produced an admirable effect, and the Duke of Connaught talked for several minutes with Major Webber. Attention was then turned to Southampton, where Mr. W. H. Preece, of the Post Office, talked as fluently with Professor Bell and Colonel Reynolds as though he were in the next room. A bugle in Southampton sounded the retreat with startling distinctness; and, lastly, came the tones of an organ from London, in charge of Mr. Wilmot.

The experiments lasted from half-past nine until nearly midnight. Her Majesty, the Princess Beatrice, the Duke of Connaught and the entire Royal Household evinced

the greatest interest. On Tuesday Professor Bell made very successful experiments between Cowes, Osborne House and Osborne Cottage, at which the Princess Beatrice, Duke of Connaught, the Duke of Richmond, Lord John Manners, Lord Ripon, Lady Biddulph, Lady Cowell, Sir John Cowell, and others, assisted.

Coached though he had been in the etiquette of presenting himself in front of the Queen and of addressing her through a third person, Bell's enthusiasm betrayed him. Her Majesty's back was turned to him just as the most striking effects were being produced by the telephone. Bell touched the Royal arm to attract her attention. Appalled at the breach — for the space of seconds — the *entourage* went rigid. Calmly, royally, Victoria took the instrument. She wrote that night in her journal:

After dinner we went to the council room and saw the telephone. A Professor Bell explained the whole process, which is the most extraordinary. It had been put in communication with Osborne Cottage, and we talked with Sir Thomas and Mary Biddulph; also heard some singing quite plainly. But it is rather faint, and one must hold the tube close to one's ear.

Expecting great elegance, Bell's disappointed impression of the Royal presence was that Her Majesty's plump hands and wrists were painfully red and chapped.

Two days later, Bell received this letter from Osborne:

My dear Sir:

I hope you are aware how much gratified and surprised the Queen was at the exhibition of the telephone here on Monday evening.

Her Majesty desires me to express her thanks to you

and the ladies and gentlemen who were associated with you on the occasion.

The Queen would like, if there is no reason against it, to purchase the two instruments which are still here, with the wires attached. Perhaps you will be so kind as to let me know to whom the sum due should be paid.

I am, dear sir, very faithfully yours

THOMAS BIDDULPH

A pair of ivory telephones, elaborately carved, were made for Her Majesty. But by the time they were ready she had lost interest, and the gift was not accepted. The telephones found their way to the United States National Museum.

With the *cachet* of Osborne House the Matinée Telephonique was a brilliant success. Two hundred people came, including the American Minister, Du Maurier and William Black, and, said Miss Field, 'the lunch was good and nobody wanted to leave.'

The next month the Society of Arts elected two life members, Professor Alexander Graham Bell in consideration of his invention of the telephone, and Mr. Henry M. Stanley because of the services to commerce in his African explorations. Later in the year Bell was to receive the Society's Silver Medal for his paper on the telephone.

(5)

That spring in London the newly formed Electric Telephone Company sponsored a little six-penny booklet entitled 'Bell's Telephone,' edited by Miss Kate Field. It was a compound of her own articles and of earlier American notices, and to prepare it Miss Field borrowed Bell's precious scrapbook, in

which he had pasted every cutting from the earliest newspaper mention of his invention. When she returned the scrapbook, Bell found that instead of copying the items she had saved herself labour by cutting them out of the book. They had gone to the printer, and were ultimately lost. To Bell this vandalism was inexcusable and far outweighed all of Miss Field's labours in his behalf. Not for years did he relax the prejudice then formed against women journalists.

In this booklet Miss Field had relieved her newspaper excerpts by comment in the form of an 'intercepted letter' in the sprightly manner which has been so overdone by her imitators, but which nevertheless gives an interesting contemporary picture of Bell. Writing as 'your telephonically devoted Puss' to a hypothetical 'Dear Ella' in Boston, U.S.A., she says:

> Professor Bell is quite a young man. He can't be more than thirty-six, and both Bob and I think him handsome. He is tall, well-made, has dark hair, very expressive hazel eyes and a mobile mouth. Fluent in conversation, he makes an interesting lecturer, and if he has as much energy as inventive ability, will soon make such improvements in the telephone as to cause even his own hair to stand on end. It is in him.

Miss Field, alone among observers, had taken the trouble to note that Bell's eyes were not black. Her hazard at his age, 'not more than thirty-six,' when Bell was actually under thirty-one, was doubtless made with the feeling that it was a flattering minimum figure. He now wore a full beard. His figure had filled out a trifle. He had a good tailor. But he still looked ten years older than he was.

CHAPTER XIV

(1)

A FEW weeks after Bell's New York lectures of May, 1877, Mr. Orton, president of the Western Union Telegraph Company, summoned his chief electrical expert, Mr. Frank L. Pope. Mr. Orton said that he had been looking into this matter of a speaking telephone, and thought that after all it might prove to be of considerable future importance. If there was anything in it the Western Union would have to own it. He wanted a report from Mr. Pope on the fundamental principles of the new art and on the patents that would have to be acquired to control it.

Mr. Pope and his assistants spent several months in exhaustive investigation, including, it is said, the search of libraries and patent offices in many countries and the employment of a gentleman who spoke eight languages to translate works on telegraphy in foreign tongues, in the quest for any hint of prior invention. After a careful digest of all this, Mr. Pope reported that no other means than Bell's existed for sending and reproducing speech by telegraph. He recommended the purchase of the Bell patents.

It was good advice, but for some reason Mr. Orton did not take it. The Western Union already owned the Page patent for the induction coil. Now the company bought the telegraphic patents of Elisha Gray, and engaged Thomas A. Edison, a former

employee and then an independent inventor, to devise some other means — any other means than Bell's — for talking over a wire. Later Elisha Gray himself, along with Professor Dolbear, was retained to the same end. Gray made application for a patent on a speaking telephone in development of his now famous caveat, filed twenty months before. To Mr. Orton it may have seemed preposterous that a teacher of elocution should have made any discovery in electricity that could not be paralleled by this experienced trio.

In December, 1877, the American Speaking Telephone Company was formed with a capital of three hundred thousand dollars, having Elisha Gray, his partner (a wealthy Philadelphian), and prominent officials of the Western Union as its stockholders. Mr. Gray and his partner had one third of the stock, the Western Union two thirds. The Company entered the field of telephony in competition with the Bell Associates, who had then over three thousand telephones in use. By the spring of 1878, Edison's new transmitter, using carbon electrodes, was successfully grafted on to the Bell telephone, greatly increasing its audibility, and the American Speaking Telephone began to push its advantage in the United States and England, supplying 'superior telephones with all the latest improvements made by the original inventors, Dolbear, Gray, and Edison'!

Meantime, Thomas Sanders was keeping the Bell telephone on its financial feet in the United States. He was the only one of the associates who had any money at that time, and although he was not a

man of great means he had a substantial business, and that priceless ingredient of business — credit. Sanders was liked and trusted, and he now threw the whole weight of his personal and financial influence back of the telephone. As months passed and increasingly large bills were run up for manufacturing and other expenses, Sanders met them out of his personal funds until that source was exhausted, and then he borrowed on his own note. 'His folly became the talk of Haverhill.' The story is told that about this time a prominent and wealthy fellow citizen met him on the street and accosted him:

'Haven't you got a good leather business, Mr. Sanders?'

'Yes.'

'Well,' he was admonished, 'you had better attend to it and quit playing on wind instruments.'

Sanders eventually advanced upwards of a hundred thousand dollars, imperilling his business and facing ruin, before he received a penny from the telephone in return.

Competition with the Western Union's subsidiary enormously increased the difficulties of the Bell group. The world's greatest corporate body not only brought into the fight its prestige and the power of its forty millions of capital, but — on every hand — it blocked the Bell Associates through its ownership of exclusive rights-of-way over housetops and along highways, its monopolies of railroad offices and hotel lobbies. Everywhere the Bell telephone turned, in Herbert Casson's telling phrase, 'the live wire of the Western Union lay across its path.'

Paradoxically, however, the rivalry of the Western Union roused public interest in the telephone as nothing else could have done. If that great corporation was going into the telephone business, every one agreed that there must be something in it. In the spring of 1878, Sanders' relatives, and -in-laws, came to his rescue and put in the needed capital to form the first New England Telephone Company.

(2)

Matters were going badly in England. The Electric Telephone Company had begun operations under Bell's patent with two testimonial letters and a list of nineteen subscribers in London, and thirty in the country — headed by Windsor Castle and Osborne House; but its path was promptly beset by rival companies exploiting infringing telephones. All the popular interest roused by Bell's early English lectures, his new scientific prestige, and the clever promotion of Miss Field were adroitly capitalized by these rivals. Edison's was only one of many competing telephones, hybrids of Bell's instrument. Fred Gower, lately manager of Bell's American lectures, turned up in London, but so far from helping Bell out of his difficulties, he made a small and unimportant change in the apparatus, called it the 'Gower-Bell' telephone, interested capital in it, and, having the business shrewdness that Bell lacked, ultimately made a fortune out of the manœuvre.

(Gower afterwards married the singer Lillian Nordica, but the union did not last. He took up ballooning and made his final appearance alone in

a balloon low down over the English Channel. A fisherman hailed him — 'Where are you bound?' 'London,' Gower shouted back. Then he drifted off into the fog, and neither the balloon nor Gower was ever seen again.)

The propaganda of these rivals seems to have been rife in England early in 1878, for on February 1st Mr. Preece spoke on the telephone at the Royal Institution and said:

> The accounts of the telephone were received in this country with great scepticism. Many even now doubt its truth until they actually test its reality. When once, however, a new thing is shown to be true, a host of detractors delight in proving that it is not new. The inventor has to pass through the ordeal of abuse. He is shown to be a plagiarist or a purloiner or something worse. Others are instanced as having done the same thing years ago, though perhaps their own existence, apart from their ideas, have never before been heard of. Professor Bell will have to go through all this; nevertheless, the telephone will always be associated with his name, and it will remain one of the marvels of this marvellous age, while its chief marvel will be its beautiful and exquisite simplicity.

In prosecuting the infringements of Bell's English patent, its owners now reaped the whirlwind so ineptly sown by Mr. George Brown. It was found that the patent could not stand in court because if an invention is 'published' in England before the English patent is applied for, even the original inventor loses his right to it. And Bell's telephone had been described in published accounts of Sir William Thomson's address to the British Association, more than a year before.

The owners, therefore, disclaimed all published descriptions and applied for a new English patent on a number of new claims, among them a claim for Bell's metallic diaphragm. This feature had not been covered in the first United States patent, and the question whether it had been published in England now arose.

A lusty rival chorus claimed that it had.

The telephone which Bell had given to Sir William Thomson in Boston had a metallic diaphragm, and the opponents of the Bell interests undertook to show that Sir William had exhibited that telephone when he made his memorable Glasgow address.

And so he had. But, it was recalled, by one of those happy accidents of history which have swayed events of greater moment, that that metallic diaphragm had been jolted out of place during the journey, had remained cocked up out of reach of the magnet, and, when Sir William had tried to demonstrate its powers, it would not work. Obviously this distorted transmitter was not Bell's. Its exhibit could not constitute publication of his invention. Sir William Thomson 'swore like a gentleman,' and the English court gave a judgment for Bell, only too well pleased to find a technical loophole which saved it from the awkward predicament of penalizing an American inventor for his courtesy in presenting his apparatus to a visiting English scientist.

(3)

That March of 1878, Bell wrote a very remarkable letter to the directors of the newly formed Electric Telephone Company, owners of his patent.

It disposes forever of the old disparagement that Bell did not know what he had done. In this letter he outlined not only the central office system but the long-distance telephone system now in use. No one understood as well as Bell the possibilities of this invention of his, which would, he knew, ultimately link cities and continents, as it then linked near-by places. Here he outlined its future with startling accuracy of vision. A copy of the letter went to each of the gentlemen forming the company. He wrote:

KENSINGTON, *March* 25, 1878

It has been suggested that at this our first meeting I should lay before you a few ideas concerning the future of the Electric Telephone, together with any suggestions that occur to me in regard to the best mode of introducing the instrument to the Public.

The Telephone may be briefly described as an electrical contrivance for reproducing in distant places the tones and articulations of a speaker's voice so that conversation can be carried on by word of mouth between persons in different rooms, in different streets, or in different towns.

The great advantage it possesses over every other form of electrical apparatus consists in the fact that it requires no skill to operate the instrument. All other Telegraphic machines produce signals which require to be translated by experts and such instruments are therefore extremely limited in their applications, but the telephone actually *speaks* and for this reason it can be utilized for nearly every purpose for which speech is employed.

The chief obstacle to the universal use of Electricity as a means of communication between distant points has been the skill required to operate Telegraphic instruments. . . . The simple and inexpensive nature of the Telephone on the other hand renders it possible to connect every man's house, office or manufactory with a Central Station

so as to give him the benefit of direct telephonic communication with his neighbours at a cost not greater than that incurred for gas or water.

At the present time we have a perfect net-work of gas-pipes and water-pipes throughout our large cities. We have main pipes laid under the streets communicating by side pipes with the various dwellings enabling the inmates to draw their supplies of gas and water from a common source.

In a similar manner it is conceivable that cables of telephonic wires could be laid underground or suspended overhead communicating by branch wires with private dwellings, Counting Houses, shops, Manufactories, etc., etc., uniting them through the main cable with a Central Office where the wires could be connected together as desired establishing direct communication between any two places in the city. Such a plan as this though impracticable at the present moment will, I firmly believe, be the outcome of the introduction of the telephone to the public. Not only so, but I believe that in the future wires will unite the head offices of Telephone Companies in different cities and a man in one part of the country may communicate by word of mouth with another in a distant place.

I am aware that such ideas may appear to you Eutopian and out of place, for we are met together for the purpose of discussing not the future of the telephone but its present.

Believing, however, as I do that such a scheme will be the ultimate result of the introduction of the telephone to the public, I would impress upon you all the advisability of keeping this end in view that all present arrangements of the telephone may eventually be utilized in this grand system.

I would therefore suggest that in introducing the telephone to the public at the present time you should on no account allow the control of the conducting wires to pass out of your hands.

The plan usually pursued in regard to private telegraphs is to lease such telegraph lines to private indi-

viduals or to Companies at a fixed annual rental. This plan should be adopted by you but instead of erecting a line directly from one point to another, I would advise you to bring the wires from the two points to the Office of the Company and there connect them together. If this plan be followed a large number of wires would soon be centered in the Telephone Office where they would be easily accessible for testing purposes.

In places remote from the Office of the Company simple testing boxes could be erected for the telephone wires of that neighbourhood and these testing places could at any time be converted into Central Offices when the Lessees of the telephone wires desire inter-communication.

In regard to other present uses for the telephone the instrument can be supplied so cheaply as to compete upon favourable terms with speaking tubes, bells and annunciators as a means of communication between different parts of the house.

This seems to be a very valuable application of the telephone not only on account of the large number of telephones that would be wanted but because it would lead eventually to the plan of inter-communication referred to above. I would therefore recommend that special arrangements should be made for the introduction of the telephone into Hotels and Private Buildings in place of the speaking tubes and annunciators at present employed.

Telephones sold for this purpose could be stamped or numbered in such a way as to distinguish them from those employed for business purposes and an agreement could be signed by the purchaser that the telephones should become forfeited to the Company if used for other purposes than those specified in the agreement.

It is probable that such a use of the telephone would speedily become popular and that as the public became accustomed to the telephone in their houses they would recognize the advantages of a system of inter-communication. When this time arrives I would advise the Com-

pany to place telephones free of charge for a specified period in a few of the principal shops so as to offer to those householders who work with the Central Office the additional advantages of oral communication with their tradespeople. The Central Office system once inaugurated in this manner would inevitably grow to enormous proportions for those shopkeepers would naturally obtain the custom of such householders. Other shopkeepers would thus be induced to employ the telephone and as such connections with the Central Office increased in number so would the advantage to householders become more apparent and the number of subscribers be increased.

Should this plan ever be adopted the Company should employ a man in each Central Office for the purpose of connecting the wires as directed. A fixed annual rental could be charged for the use of the wires or a toll could be levied. As all connections would necessarily be made at the Central Office it would be easy to note the time during which any wires were connected and to make a charge accordingly. Bills could be sent in periodically. However small the rate of charge might be the revenue would probably be something enormous.

In conclusion I would say that it seems to me that the telephone should immediately be brought prominently before the public as a means of communication between Bankers, Merchants, Manufacturers, Wholesale and Retail Dealers, Dock Companies, Gas Companies, Water Companies, Police Offices, Fire Stations, Newspaper Offices, Hospitals, and Public Buildings, and for use in Railway Offices, in Mines and in Diving Operations.

Arrangements should also be speedily concluded for the use of the telephone in the Army and Navy and by the Postal Telegraph Department.

Although there is a great field for the telephone in the immediate present, I believe there is a still greater in the future.

By bearing in mind the great objects to be ultimately achieved, I believe that the Telephone Company can not only secure for itself a business of the most remunerative

kind but also benefit the public in a way that has never previously been attempted.

So far as the telephone in England was concerned, this letter was Bell's swan song. Bell was aware, he said, that these ideas might appear Utopian, and out of place, and so indeed they seemed to the directorate. Long afterward, on a visit to England, he tried to locate a copy of this letter. He asked several of the recipients what they had done with it. In effect the answer went, 'Well, I rather smiled at it and tore it up.'

(4)

In April, England was tense with the threat of war with Russia. The fleet went to the Dardanelles, Disraeli asked Parliament for a vote of six millions credit, called out the reserves, and sent 7000 Indian troops to Malta. The music halls contributed to the language that deathless chant —

> 'We don't want to fight, but, by jingo, if we do,
> We got the ships, we got the men, we got the money too!'

Office and street echoed to 'The Russ'ns shall not 'ave Constan-te-no . . . ple.'

When 'H.M.S. Pinafore' was produced at the Opéra Comique the next month, Ralph Rackstraw was loaded with chains and consigned to his dungeon to the mournful chorus of the Boatswain, Dick Deadeye and Cousin Hebe,

> 'He'll hear no tone
> Of the maiden he loves so well!
> No telephone
> Communicates with his cell!'

In Kensington, that May, the first Bell daughter was born. On the 17th, A. Graham Bell, Esq., addressed the Royal Institution on 'Speech,' and spoke of the possibility of hearing a shadow by interrupting the action of light on selenium.

(5)

In the United States that summer, a second company was formed to operate under the Bell patents outside of New England, and as the summer advanced, cabled requests reached Bell from Boston for evidence to be used in its first American suit. The little Bell Company was preparing to sue the Western Union (nominally an agent of its subsidiary company) for manufacturing and selling telephones under Bell's patent. To Bell's amazement he learned that the Western Union bolstered its case with the claims — among others — of Mr. Elisha Gray, his old rival in the harmonic telegraph, who had congratulated him so warmly at the Centennial on the invention of the electric speaking telephone, and Professor Dolbear, who had long ago written to wish him the fame and fortune so justly his.

One cable followed another. Where were the contemporary newspaper cuttings, showing the chronological development and demonstrations of his invention? His lawyers wanted them. He tried to recover them from Miss Field, and could not. Where were his letters from Elisha Gray? He didn't know — he had tossed them somewhere. When he answered that cable, he used to say, he thought that he had lost the telephone. But his associates

had the Exeter Place rooms searched, and in an unemptied waste-paper basket, so Bell used to say, the missing letters came to light.

Bell was a fighter, but he fought fair, and the chicanery he had encountered in his efforts to establish the telephone in England had at first perplexed and then angered him. The whole sorry business was nauseous to a man of Bell's rigid honesty. If the Western Union was coming into the field with weapons like these, with all its money and influence behind it — he threw up his hands. They could take the telephone for all of him. He would go back to his profession, to a field he knew. But there was more in his gesture than distaste for a losing fight with unscrupulous rivals. His expenses had been heavy. He had a wife and child on his hands, he was harassed with debts, and he was out of funds.

As autumn came, the Bell Company was notified by its counsel that, excepting Bell, all the parties to the suit had filed their statements, and that Bell's statement must be secured without delay. In reply to an urgent request, Bell wrote flatly that he was leaving England, taking his wife and child directly to his father's house in Canada, and was not coming to Boston at all. He had had enough of the telephone. He was through with the telephone. He was going back to teaching. Late in October, he gave four lectures on 'Speech' at Oxford.

The tone of his letter must have conveyed all this with considerable finality, for Mr. Hubbard abandoned written behests. Watson was despatched to meet the Allan Line steamer at Quebec

and to fetch Bell by hand to Boston. The steamer arrived on November 10, 1878. 'I found Bell,' Watson says, 'even more dissatisfied with the telephone than his letters had indicated. He told me that he wasn't going to have anything more to do with it, but was going to take up teaching again as soon as he could get a position.'

Watson succeeded in convincing Bell that the telephone had an assured future in the United States, and 'finally he said he would go to Boston with me after he had taken his wife and child to his father's house in Ontario.' Watson very prudently went along, 'for I didn't want to run the risk of losing him, and stayed there several days before I succeeded in getting him started for Boston. He would not go until he received an affirmative answer to a telegram he dictated and had me send to Boston, of which I find a copy in my notebook. It reads, 'Will company pay Bell's expenses incurred in its services to Boston and back?'

'Of course,' Watson says, 'the answer was "yes." Bell was sick and had to go to bed as soon as he got on the sleeper. On arrival in Boston, he went to the Massachusetts General Hospital for an operation. His preliminary statement, dated November 20, 1878, was made while he was there, but it was filed in time, and, perhaps, saved his patent.'

This was genuine illness, yet, in the circumstances, it was one of Bell's most characteristic gestures. Illness was always his defence. It defended him alike from the pleas of duty and from uncongenial social demands. When he was angry or bored, he went to bed. It saved argument.

(6)

Long before the case against the Western Union was concluded, the merits of the rival Edison transmitter had begun to affect the Bell leases, and the Bell Company was looking frantically about for an equivalent improvement. Emile Berliner was then on its staff, but his invention of a carbon transmitter had not then been proved to antedate Edison's, and it was not until that October of 1878, when Francis Blake appeared with the Blake transmitter, that the company got back to an even footing with its competitor. Something of the Company's embarrassments is reflected in brief extracts from its early correspondence; 'How on earth do you expect me to meet a draft of two hundred and seventy-five dollars,' Sanders wrote to Hubbard, 'without a dollar in the treasury, and with a debt of thirty thousand dollars staring us in the face?' And again: 'Vail's salary is small enough, but as to where it is coming from I am not clear. Bradley is awfully blue and discouraged. Williams is tormenting me for money and my personal credit will not stand everything. I have advanced the company two thousand dollars to-day, and Williams must have three thousand dollars more this month. His pay-day has come and his capital will not carry him another inch. If Bradley throws up his hand, I will unfold to you my last desperate plan.'

It was about this time that Mr. Sanders' banker informed him that he would be obliged if Sanders would take his telephone stock out of the bank and give him in its place his personal note for thirty thousand dollars. The examiner was expected in a

few days, he said, and 'I don't want to get caught with that stuff in the bank.'

There seemed no end to their difficulties. Months on end salaries were not paid in full; the staff lent each other car-fare, and shared their lunch-pails; and Bell, discouraged and ill, wrote bitterly to the Company that, though thousands of telephones were in operation in all parts of the country, he had not yet received one cent from his invention. 'On the contrary,' he wrote, 'I am largely out of pocket by my researches, as the mere value of the profession that I have sacrificed during my three years' work amounts to twelve thousand dollars.' He needed a thousand dollars at once to pay urgent debts.

Bell was dissuaded from his intention of going back to teaching, however, and remained in Boston with the company, at a salary of five thousand dollars — nominally as electrician, but actually to assist counsel in its case against the Western Union.

The Western Union fought vigorously, and evidence was taken for a year. When the testimony on both sides was substantially closed, Mr. George Gifford, the Western Union counsel, informed his clients that Bell was unquestionably the first inventor of the telephone and advised a settlement with the Bell Company. A settlement was made, pooling the patent rights of both groups, on a basis of one fifth interest to the Western Union, and four fifths to the Bell Company. The proportion tells better than any comment the relative value placed on the Bell patent, which was all that the Bell Company had. The powerful coöperation of the Western Union was cheaply purchased at a one-fifth share.

Immediately the stock of the Bell Company shot up in value. In December, 1879, it sold at $995 a share, although the company had never paid a dividend.

CHAPTER XV

(1)

Bell's telephone patent has been called the most valuable single patent ever issued. The suits brought against its infringers form the most protracted patent litigation in history; and it is doubtful if any other litigation ever roused the passion and cupidity of rivals as the Bell suits did.

The personal abuse and calumny heaped on Bell in person throughout these years of litigation was the more unreasonable considering the familiarity of the public with his early struggles, and his unassailed position as the sole inventor, during the year and a half from the exhibit at the Centennial to the commercial success that roused the first rival claim. The early ridicule of Bell as a crank and a visionary was scarcely succeeded by public recognition of his genius and of the value of the telephone, when a host of claimants arose to take both away from him.

At first the assaults were made only in terms of prior invention, but as the number of claimants grew — from Gray, Dolbear, and Edison, to Drawbaugh, Varley, Meucci, Holcomb, and the rest — and as the commercial value of the telephone patent became more apparent, the first minor disparagement of Bell mounted to a shrill crescendo of abuse in which he was denounced as a perjurer, a fraud, and a thief! Poor Bell! Probably no inventor ever lived who could and did show a clearer title to his invention. In every suit fought on the Bell patents

(ultimately there were something like six hundred of them) the courts sustained Bell as the original inventor. Five suits were carried to the Supreme Court of the United States and the five decisions were for Bell. Testimony was taken for years on end, patent offices were ransacked, eminent professors of physics were invoked as experts, and not a shred of evidence could be produced to show that any one before Bell had discovered a way to talk by telegraph. After the conclusion of the first suit, which had presumably disposed of the Gray, Dolbear, and Edison claims as prior inventors, all of these claims were put forward again by separate interests, and other interests pushed the fictions of a dozen other inventors, from preposterous Mr. Drawbaugh to pathetic old Antonio Meucci, friend of Garibaldi, who seems to have been honestly deluded into the belief that talking mechanically over a wire was the same thing as electric speech.

The force of prejudice against Bell at this time is the more difficult to understand when one surveys the flimsy evidence advanced for all these claimants, as opposed to the overwhelming proofs of his own prior invention. The obvious conclusion is that the public either did not read the evidence or did not sufficiently understand the principle of Bell's telephone to appreciate the evidence. It was probably both. The public did not realize, and Bell's rivals strove to prevent it from perceiving that it was Bell's method more than his apparatus that underlay electric speech. Once his method was known, it was easy to adapt other mechanism, and even to improve on his own mechanism, to send speech over a wire.

This babel of claims was accompanied by a medley of exhibits, tin dippers, and teacups, and mustard tins, by means of which various inventors claimed to have antedated Bell's discovery; and when they were operated on Bell's electro-magneto method, they came measurably near to transmitting speech. The thing was so simple. As Mr. Preece said, so exquisitely and beautifully simple. That was the trouble. Once one knew how, there was nothing to prevent any one from making a telephone out of an old cigar box, operating it on Bell's undulatory electric current, and solemnly asserting that he had been talking to the neighbours for years.

Some of these suits, viewed at the distance of forty years, seem truly Gilbertian.

One inventor asserted that he had invented Bell's telephone years before, but, at the time, he didn't know what it was. In another suit a Reis telephone was offered as evidence in court, and when it failed to transmit speech counsel for Bell's rival explained, 'It can speak, but it won't!' But of these, the name of Daniel Drawbaugh leads all the rest. Drawbaugh was a professional inventor, a man of fifty-odd, whose florid advertising card read, 'Inventor, Designer, and Solicitor of Patents.' He was a clever mechanic, and subscriber to the *Scientific American*, and from this journal and from encyclopædias picked up many of the ideas with which he astonished his simple neighbours. Drawbaugh came from the little Pennsylvania village of Eberly's Mills, and when he was put forward as a prior inventor of Bell's telephone a host of honest country people came forward to testify to 'what an ingenious man he was, how he

could invent anything, and how he had invented a talking machine.' Obviously all these people could not be perjured, and the probabilities are that Drawbaugh had once constructed a stick telephone on the principle of Wheatstone's deal rod, or a string or wire telephone carrying speech mechanically from one floor of his workshop to another, both familiar long before 1876. But what he actually had, and what these truthful German farmers listened to, nobody knows but Drawbaugh.

What he claimed to have constructed as early as 1875 was not only the Bell telephone, but the Hughes microphone, and the Edison and Blake transmitters! All that was essential of these, Drawbaugh asserted that he had perfected and put in operation before he went to the Centennial and saw Bell's telephone there in the summer of 1876. He spent five days at the Centennial, with a friend, and admitted in evidence that, although he had heard much of Bell's exhibit and knew what it was, he never said anything to anybody about all the greater wonders that he had back home in Eberly's Mills. In fact, he said nothing about his great achievement until four years later, when Bell's telephone was in wide use, after many descriptions of it had been published, and when attacks on the Bell patents had become popular forms of speculative investment. Drawbaugh's astonishing reticence about his discoveries in telephony was the more remarkable, since he had been doing very well with a faucet invention and an electric clock, although opposing counsel unkindly disclosed that this last had been copied from an encyclopædia.

His explanation for his silence was simple. He was a poor man and couldn't afford to take out a patent. This absurdity was to cling for years about Drawbaugh's and a number of other worthless claims, lending them validity and concealing their unwholesomeness with its honest, homely aroma. Bell's poverty was forgotten.

In Drawbaugh's case it was shown that he had earned ten thousand dollars in the ten years before he advanced his claim to Bell's telephone, that he had bought real estate, and that friends had invested considerable sums in his various devices. It was manifestly absurd to say that in four years he had not been able to afford the small fee for a patent.

But one can almost forgive Mr. Drawbaugh his fables for the entertainment his evidence affords. Questioned on his discovery of electric speech, he declared: 'I don't remember how I came to it. I had been experimenting in that direction; I don't remember of getting at it by accident either; I don't remember of any one telling me of it; I don't suppose any one told me.'

In his decision Judge Wallace commented dryly, 'An inventor can hardly forget the process of thought by which a great intellectual conception germinates and matures into the consummate achievement, but Drawbaugh's memory is a blank.'

But all the claimants to Bell's telephone were not so ridiculous. Many inventors, notably Farmer, Gray, and Dolbear, had been working along the same lines and had come close to Bell's discovery. But they knew too much about electricity and not

enough about sound. It was Moses G. Farmer who could not sleep for a week when he first heard about Bell's telephone, he was, he said, 'so mad' with himself for not discovering it long before.

It is easy to understand how exasperating it must have been for such men to have that stupendous secret of Electricity disclosed to a man less familiar with her ways than they. Many of these men had done and were still to do notable work in electrical science. Although Gray's own admissions in contemporary letters invalidated his claims at the outset, as he grew older he became progressively more antagonistic and irreconcilable. He probably died in the firm belief that he had been defrauded of his just rights. 'Of all the men who didn't invent the telephone,' his partner said ultimately, 'Gray was the nearest.'

(2)

The tenacity of rival claims to the electric speaking telephone is not exclusively American. Despite the honours bestowed on Bell by Wurzburg, despite Heidelberg's honorary M.D., despite the decision of the German Patent Office, after a search lasting two years, that Philip Reis had not invented a speaking telephone, a Munich museum now presents its exhibit of Reis as that of the inventor of the telephone, and lists Bell among inventors who contributed to the art. Italy still unveils tablets to Antonio Meucci, who talked over a wire on Staten Island long ago, and filed a caveat in the United States Patent Office for the 'well-known conducting effect of continuous metallic conductors as a medium for sound.'

A decision of the Patent Office in the telephone interferences summed up the curious situation thus:

> It is an historical fact that the introduction of valuable and important inventions is productive of a host of rival claimants; and so the steady growth and assured success of the articulating telephone as a commercial venture had the usual effect of developing, reviving, and resurrecting all manner of inventions, and contrivances, both near and remote, upon which the mere shadow of a claim to priority could possibly be based, whereby the honors and profits justly due to its author could be secured.
>
> Stimulated by visions of glory and profit, all manner of incomplete, dormant, unsuccessful, and abandoned inventions and devices have been brought to light, polished, and made to resemble as much as possible the real article, in order that their projectors might obtain, or at least participate in the profits.

CHAPTER XVI

(1)

WHILE in England, in 1878, Bell had heard a great deal about Willoughby Smith's work with selenium.

This led him to the photophone, the first wireless telephone.

Selenium was then known as a new elementary substance, discovered in 1817 by Berzelius. In its crystalline form it was known to have very high resistance to an electric current. Willoughby Smith and his assistant, Mr. May, using the stuff in their Atlantic cable experiments, discovered that its resistance was variable; and, searching for the cause of its uneven behaviour, Mr. May found that the resistance was less when the selenium was exposed to light than when it was in the dark.

The announcement of this hitherto unknown property of selenium created a sensation among scientific men. Half a dozen physicists began to test selenium's sensitiveness to light. They read papers before learned bodies and wrote letters to scientific journals. When Bell reached English shores in '77, the British Association and the Royal Institution were still palpitant with their disclosures.

In all these tests with selenium the galvanometer had been used to measure the effect of light on the substance. It occurred to Bell that the telephone would be a much more sensitive instrument to use. The same idea now seems to have occurred to a number of other men. But no effect can be pro-

duced in a telephone during the passage of a continuous, steady current. It is only at the moment of change from a stronger to a weaker state that any audible effect is produced — in other words, unless the current varies in intensity, there isn't any sound.

Bell knew, however, that musical sounds could be produced in the telephone if the current was rapidly interrupted. He thought that if a beam of light could be focussed on a bar of selenium and then interrupted with great rapidity, it might register a musical tone in the telephone. In May, in his address at the Royal Institution of Great Britain, Bell had spoken of the possibility of hearing a shadow by interrupting the action of light upon selenium. A few days later, Mr. Willoughby Smith announced that by means of the telephone he had heard a sound from a ray of light striking a bar of selenium. A correspondent of *Nature* suggested the same thing, and, just before Bell left England to return to America in the autumn of 1878, Mr. A. C. Brown, of London, submitted to Bell the details of his 'most ingenious invention' for producing speech by the action of light on selenium. Brown's method was entirely different from the one Bell ultimately used, but Bell was scrupulously careful to give him full credit for the apparatus he had devised and for his independent conception of the idea that an undulatory beam of light would do without a line what Bell's undulatory current of electricity did along a wire.

Bell does not reveal the details of Brown's method, confidentially submitted, and he did nothing of any importance with the idea himself while in England.

He had too many irons in the fire. But he got some selenium, only to find its resistance 'almost infinitely greater' than any telephone that had been constructed. And Bell hadn't the slightest practical skill in making apparatus. He had to have an assistant, and when he got back to the United States to find Watson occupied with the telephone business, he found his next co-worker in Sumner Tainter, another graduate of the Williams shop. 'It is greatly to the genius and perseverance of my friend Mr. Sumner Tainter, of Watertown, Massachusetts,' Bell said later, 'that the problem of producing and reproducing sound by the agency of light has at last been successfully solved.'

(2)

Bell was living in Washington during these experiments with the photophone, and he and Tainter worked in his laboratory at 1325, L Street, a little two-storey building which Tainter had fitted up, not far from the Franklin High School.

The preparation of selenium for preliminary experiments was a tedious and complicated process. The stuff looked like black sealing wax, with a smooth, glossy surface, and in thin films was transparent, showing ruby red against the light. In this form it was a non-conductor of electricity. But when heated almost to the fusing point and then cooled very slowly, it took on a dull lead-like appearance. In this crystalline state it was a conductor of electricity, but of extremely high resistance; so high, that a narrow strip of selenium, an inch or two long, offered as much resistance to the passage of an elec-

trical current as ninety million miles of insulated wire — as far as from the earth to the sun. But it was a conductor, nevertheless. To get it into its crystalline state, at one point in Bell's experiments, the substance had to be put into a small container, with a thermometer, the container placed in a pot of linseed oil, and this pot placed on glass supports in a third and outer container holding more linseed oil. The whole was then heated over a gas flame to the required temperature and kept at that temperature for twenty-four hours. Then it had to be packed in an insulated box for from forty to sixty hours to cool down to the temperature of the air. A powerful battery current was passed through the selenium during the whole process of heating and cooling.

This elaborate and prolonged ritual irked and exasperated Bell.

He tossed a piece of selenium into a pot, put it over a gas-burner and let it heat. He watched it, and when it looked about right he took it off and let it cool. The whole operation occupied only a few minutes — and the stuff was just as sensitive as when prepared in the long and complicated manner. It was, at least, for his purposes. Bell didn't try to conceal his satisfaction when he told the circumstances later to the American Association for the Advancement of Science. It proved, he said — with emphasis that would have been a whoop in the laboratory — that 'many of the accepted theories on this subject are fallacious.' And if there was one thing he really enjoyed, it was taking a lusty crack at an accepted theory.

(3)

More than fifty forms of apparatus were devised and discarded. The simplest and best of them operated by means of a plane mirror of silvered mica or microscope glass thin enough to vibrate to the tones of the voice. When words were spoken into the mirror, a beam of light reflected from the mirror was thrown into corresponding vibrations, and directed by a lens and a parabolic reflector onto the sensitive selenium cell. The cell, in circuit with a telephone, conveyed the words to the listener. It was the first wireless telephone.

Satisfactory effects had been achieved indoors, but a beam of light, unfortunately, couldn't be run from room to room like a wire, and to get out of ear-shot the receiving telephone had to be extended to another room. With February, 1880, the apparatus was ready for a test out-of-doors. On the 15th, Bell went to the laboratory only for an hour. He couldn't remain, because another baby was expected at his house, and he had promised to be within reach.

It was a beautiful, clear February day, brilliant with sunshine. Tainter took the transmitting apparatus to the top of the Franklin School building, a little over two hundred and thirty yards away. Listening in the workshop, Bell heard:

Mr. Bell, Mr. Bell, if you hear what I say, come to the window and wave your hat!

Bell rushed to the window, and waved. The photophone was born.

Bell forgot to go home.

A messenger found him later, absorbed in this

latest child of his brain, to tell him that he had a new daughter.

(4)

In August that year, Bell read his paper on the photophone before the Boston meeting of the American Association for the Advancement of Science. He called it 'On the Production and Reproduction of Sound by Light.' In concluding his account of Sumner Tainter's work and his own he said:

I am extremely glad that I have the opportunity of making the first publication of these researches before a scientific society, for it is from scientific men that my work of the last six years has received its earliest and kindest recognition. I gratefully remember the encouragement which I received from the late Professor Henry, at a time when the speaking telephone existed only in theory. Indeed, it is greatly due to the stimulus of his appreciation that the telephone became an accomplished fact.

I cannot state too highly also the advantage I derived in preliminary experiments on sound vibrations in this building from Professor Cross, and near here from my valued friend Dr. Clarence J. Blake. When the public were incredulous of the possibility of electrical speech, the American Academy of Arts and Sciences, the Philosophical Society of Washington, and the Essex Institute of Salem, recognized the reality of the results and honoured me by their congratulations. The public interest, I think, was first awakened by the judgement of the very eminent scientific men before whom the telephone was exhibited in Philadelphia, and by the address of Sir William Thomson before the British Association for the Advancement of Science.

At a later period, when even practical telegraphers considered the telephone a mere toy, several scientific gentlemen, Professor John Pierce, Professor Eli W. Blake, Dr. Channing, Mr. Clark and Mr. Jones, of Providence,

Rhode Island, devoted themselves to a series of experiments for the purpose of assisting me in making the telephone of practical utility; and they communicated to me, from time to time, the results of their experiment with a kindness and generosity I can never forget. It is not only pleasant to remember these things and to speak of them, but it is a duty to repeat them, as they give a practical refutation to the often repeated stories of the blindness of scientific men to unaccredited novelties, and of their jealousy of unknown inventors who dare to enter the charmed circle of science.

I trust that the scientific favour which was so readily accorded to the Telephone may be extended by you to this new claimant — 'The Photophone.'

Later, Bell and Tainter sent musical tones by this wireless telephone from the top of the Franklin School to the hills on the north of the city, a distance of about a mile and a quarter. The next year they abandoned the term 'photophone' for the more precise 'radiophone,' suggested by the French physicist M. Mercadier, but Bell always referred to it, in later life, as the photophone.

Although the photophone could be used by day or night, its use was limited to clear skies and it could not operate in a fog. Its principal advantage was in its secrecy, as its messages could not be tapped. It was adopted by the German Government for lighthouse work.

Under Bell's old contract with his associates he had agreed to give to the Bell Company all inventions in telephony which should succeed the electric speaking telephone.

Triumphantly, he now presented them with the photophone.

But the harassed telephone company, still beset

with the problems of a new industry and fighting its way through a mob of infringing concerns, apparently put it away on a shelf until they could get the call bells perfected and stop some of the noises on the wires.

That the photophone might have been profitably developed earlier than it was seems unlikely, but whether its later development was unreasonably delayed, as Bell thought it was, is a moot point. Bell's own phrase was 'They put it in a pigeonhole.' He did some work afterward on an automatic switchboard, but he said years later that his interest in telephony lapsed with the 'pigeonholing' of the photophone.

That year Bell sealed up all his records of the invention and deposited them with the Smithsonian Institution for preservation. An amusing story came of the incident. Somehow the news leaked out that Alexander Graham Bell had deposited a sealed package in the Smithsonian Institution, and the rumour grew that its contents concerned an invention for seeing by telegraph. Somewhere a news paragraph appeared to this effect, and was widely copied in America and abroad. Instantly furious inventors wrote to the papers on two sides of the Atlantic, each claiming the invention as his own, denouncing Bell as a fraud and his alleged discovery as a theft! Of course he had not discovered any method of seeing by telegraph, and neither had they. Forty years and more were to elapse before any one did see by electricity. The episode is not without its point in considering the clamour of rival claimants to the electric speaking telephone.

(5)

Bell's American experiments were interrupted in the late summer and autumn of 1880 because, he said, 'circumstances called me to Europe.'

The circumstances were the award of the Volta Prize of fifty thousand francs, by the French Government, for the invention of the electric speaking telephone.

The Volta Prize, established by the first Napoleon and named in honour of the great Italian physicist Alessandro Volta, had been awarded only once before, when it was bestowed on Ruhmkorff for his induction coil.

Although Bell received the Legion of Honour the next year and was to be the recipient of scores of lesser dignities in his lifetime, this award of the Volta Prize when he was thirty-three was, in his estimation, the greatest distinction that ever came to him.

(6)

While in Paris, Bell made some experiments 'to test the sonorousness of all matter under the influence of intermittent light.'

If selenium gave off a sound to a sunbeam, he reasoned, why shouldn't there be other substances responsive to light? In these tests Bell used a rapidly interrupted beam of light as in some of his early photophone experiments, but he abandoned the telephone for a plain hearing tube.

The Paris skies were cloudy and Bell wrote impatiently to Tainter that it was next to impossible to get a glimpse of the sun. Even when it was visible, 'the intensity of the light,' he wrote, 'is not to be

compared with that to be obtained in Washington.' For once, Bell, who cherished grey skies, wanted the sun to shine.

Nevertheless, there was enough light in the Rue Cambon that October to satisfy him as to the general sonorousness of matter, and to make a communication on the subject to the French Academy, through M. Antoine Bréguet. By November he had got a sound from a test tube full of tobacco smoke, from crystals of bichromate of potash, from water discoloured with ink, and 'a whole cigar placed in the test tube produced a very loud sound'! A cigar singing in the sun! That was worth a choir of a hundred voices from selenium to the pathfinding Bell.

He wrote to Tainter suggesting further researches with other substances under the more favourable American skies, and in London a little later that month he stood over a test tube in the laboratory of the Royal Institution demonstrating his results to the great Tyndall. At the time, Tyndall was making parallel researches in the subject, and so were Preece, Mercadier, and Röntgen — who is best known for his ultimate discovery of the X-ray.

Back in Washington early in January, 1881, Bell found that Tainter had made long strides in the production of sound by light. He had got a tremendous note from a teaspoonful of ordinary lampblack. They ultimately found it to be one of the most sensitive substances known, and a lampblack receiver was made for the photophone and successfully used in place of the electrical receiver formerly employed.

Out of these experiments with silks and worsteds,

with blue and lilac wools, with zinc filings and water discoloured with ink and iodine, Bell and Tainter devised the spectrophone, designed for measuring by the ear the invisible part of the spectrum. 'I recognize the fact,' Bell said in presenting his and Tainter's conclusions to the Philosophical Society of Washington, 'that the spectrophone must ever remain a mere adjunct to the spectroscope, but I anticipate that it has a wide and independent field of usefulness in the investigation of absorption spectra in the ultra-red.'

In communicating the results of all these researches in the production of sound by radiant energy to the National Academy of Sciences that April, Bell concluded with this characteristic remark: 'It is often more interesting to observe the first totterings of a child than to watch the firm tread of a full-grown man, and I feel that our first footsteps in this new field of science may have more of interest to you than the fuller results of mature research. This must be my excuse for having dwelt so long upon the details of incomplete experiments.'

The first footsteps of his own child, who had shared her birthday with the photophone the year before, doubtless suggested the parallel, and the point of view is typical of Bell's perennial attitude toward his work. As soon as any line of research outgrew these first totterings, when — to pursue the metaphor — it began to stand squarely on its own feet, his interest waned.

(7)

In England, in the autumn of 1880, Bell had talked with his cousin Dr. Chichester A. Bell about

the inconstant action of selenium. Bell and Tainter had found that no two pieces of selenium had the same resistance, and that often sections of the same stick varied widely. Chichester Bell was a chemist, then on the faculty of University College, London. He suggested chemical tests of selenium to determine the cause of this variability, and a few months later he joined his cousin at Washington.

With the fifty thousand francs of the Volta Prize, Bell now established his Volta Laboratory. This sum, the equivalent of ten thousand dollars in those days, was to finance experimental work in which Chichester Bell and Sumner Tainter as associate were to share and profit jointly with Bell. That summer the laboratory was established at 1221, Connecticut Avenue, in a small brick building that had been a stable. It stood in the rear of the site of the present Church of the Covenant. Contemporary description places the little structure 'in the centre of a large piece of land within a block of the residence of the British Minister' (now the British Embassy).

CHAPTER XVII

(1)

In June, 1881, Lieutenant Greely, U.S.A., was laying in supplies of fat pork, damson jam, onions and cucumber pickles for his Arctic expedition to Lady Franklin Bay. All over the country, young men heard class prophecies projecting them into the new century, twenty years away, and young women in gowns of nun's-veiling formed processions and sang, as now, 'Dear Alma Mater, farewell, farewell.' The President, James A. Garfield, spending a short holiday at Long Branch, New Jersey, strolled by the bluffs listening to the roar of the ocean, and found it, in the acid comment of the New York *Herald*, infinitely sweeter than the roar of the Ohio politicians clamouring for office in the Executive Mansion.

July came in with sweltering heat. On the second day of the month, the President, back from Long Branch, was leaving Washington again for the commencement exercises of Williams College, Williamstown, Massachusetts. He drove to the railway station of the Baltimore and Potomac, informally, as American Presidents did then, accompanied only by his Secretary of State, Mr. Blaine. The waiting-room was nearly empty. The President walked up to a policeman to ask how much time he had before his train. The officer looked at his watch. Mr. Garfield had ten minutes. He thanked the officer and walked away, and then there was a sharp report which the policeman on duty at the main entrance

thought to be a firecracker, set off by some boy in the President's honour. In another instant the station was in an uproar. A deranged office-seeker, Guiteau, had shot Mr. Garfield down as he crossed the waiting-room, wounding him with two bullets, one of which seems to have been intended for Blaine.

One bullet penetrated the President's back on the right side between the lower ribs and an inch or two from the spine. He was hurried back to the White House, and for hours no one knew whether he would live or die.

The events of the next ten weeks make painful reading. Heat, the breathless, torrid heat of July beat down on the city. The bullet in Mr. Garfield's body was presumably lodged somewhere in the lower abdomen. The President, in his vigorous fifties, had a splendid constitution, but no one could predict the end until the location of the bullet was known. It might be so lodged as to become safely encysted, but otherwise recovery would depend upon its removal. Eighteen eighty-one knew no X-ray. Probing, the only means of ascertaining its position, was attended with grave risk. And, contemporary opinion said, there were too many doctors.

In the excitement of the assassination, physicians had been summoned from all points in the city, and when the absent family physician hurried back to Washington most of these first-comers declined to withdraw. A most distressing situation resulted, in which the press took sides, and 'The Physicians Quarrel' took a place in the news nearly as prominent as the condition of the wounded President, pluckily holding on to life. 'Medicus,' 'Old Practi-

tioner,' and 'Common-Sense' all wrote to the papers criticizing the treatment, recommending diets, and hostile newspapers demanded editorially 'Where is the bullet?'

Graham Bell, then in Boston, thought that something might be done to locate it with the induction balance. He remembered that, in his English experiments of 1878, 'at every point in the field of induction it was found that by turning the plane of the exploring coil a position of silence could be obtained, and . . . when a position of silence was established a piece of metal brought within the field of induction caused the telephone to sound.' He had used silver coins in these experiments, but other metals would produce similar effects, and now it occurred to him that, if it was not too deeply buried, the lead of Guiteau's bullet might answer audibly to the exploring coil of an induction balance.

The week after the shooting, Simon Newcomb was interviewed in Washington concerning a rumour that he had suggested some electrical device for detecting the presence of the bullet. Professor Newcomb thought the construction of the apparatus would be too difficult and too prolonged, but meantime Graham Bell had seen the newspaper account and wired to offer his assistance to Newcomb in the experiments. That week Mr. George M. Hopkins, of the *Scientific American*, wrote to the New York *Tribune* suggesting the use of the induction balance for the same purpose.

After an exchange of telegrams with Simon Newcomb, Bell and Tainter went on to Washington and drove to the White House, past the hushed picnic

parties silently eating their lunches in Lafayette Square, watching the comings and goings at the Executive Mansion; past the guards sprawling on the dry lawns.

(2)

Washington still sweltered in the abnormal heat of that July. It was a horse-drawn era, and the city, in Bell's own phrase, swarmed with flies and smelled like a stable. A warm malarial wind blew from the undrained Potomac swamps below the White House, and the President was moved from his southern sick-room to a northwest exposure. Cold air was pumped up from the basement through the hot-air registers and the stricken President sipped iced champagne and dozed to their tinny rattle.

A Washington newspaper correspondent wrote:

> Professor Graham Bell and Professor Tainter came here from Boston to-day for the purpose of making, under supervision of attending surgeons, a series of experiments intending to test the practicability of ascertaining by electrical means the location of the bullet which lies embedded in the President's body. They were driven at once to the Executive Mansion and are now, together with Prof. Newcomb, in the surgeon's room.

Bell got in touch with Mr. Hopkins, of the *Scientific American*, telegraphed to Professor Trowbridge, of Harvard, to Professor Rowland, of Johns Hopkins, and cabled to W. H. Preece in London:

> WASHINGTON *July* 15 1881
>
> Can Hughes suggest form of induction balance to locate leaden bullet in President? If so cable at my expense.
>
> GRAHAM BELL

The huge induction coils once used by Professor Henry were loaned by the Smithsonian, and, to test battery power, the electrician at the Capitol sent twenty enormous Bunsen elements which had formerly been used to light the gas at the Capitol. The Western Union Telegraph Company lent an electric motor. It was difficult to devise successful apparatus for a test of this kind, because, while the device had to be most delicately adjusted, it had to be movable, and it had to be small.

There were no electrical workshops nearer than Baltimore. Contributing experiments were carried on under Bell's direction in the Baltimore workshop of Davis & Watts, and in Charles Williams' shop in Boston. Tainter worked ceaselessly in the new Volta Laboratory. Repeatedly that week of the 15th, the President's carriage stood outside the little Connecticut Avenue building, while one or another of the White House surgeons witnessed Bell's experiments. He and Tainter held bullets in their mouths, in their clenched hands, under their armpits, while the onlookers listened at the telephone for the faint sound that promised the only means of finding the lead that daily brought the President nearer death. New forms were tried, new adjustments made, bullets were fired against boards to flatten them and buried in bags of wet bran to approximate the electrical resistance of the human body. Joints of meat came from the butcher to receive bullets in their depths, more nearly approximating the dreadful reality. In the pitiless heat, Bell and Tainter worked steadily, scarcely stopping for sleep. That week four members of the White House staff came down with malaria.

(3)

With the first measurable success of the device, preliminary tests were made on the persons of a number of old soldiers who still carried Civil War rifle balls, and on the 26th of July the apparatus was taken to the White House. In the early evening, when the President's wound was being dressed, Bell and Tainter made their first attempt to locate the assassin's bullet. There were five physicians and several White House attendants present. Mr. Garfield looked apprehensively at the connecting wires which trailed across his body, fearing to get a shock, and asked for an explanation of the device before they went on. His weary eyes never left Bell throughout the test. The result was inconclusive, and the experiment was not prolonged for fear of tiring the patient. Bell wrote to Dr. Bliss the next day, concluding, 'If it is not important to locate the bullet at the present time, it might be well to postpone a repetition of the experiment, so as to give Mr. Tainter and myself more time to improve our apparatus.' There was no crisis. The President seemed stronger. He sat up and was able to have a sandwich and a glass of tokay. The newspapers said, 'In consequence of the improved condition of the President the daily services of prayer at the Vermont Avenue Christian Church will be suspended.'

The Secretary of the Navy ordered the United States steamer Tallapoosa to be made ready for sea on August 12, in readiness for a sea voyage for the President's convalescence.

On the last day of July, Bell wrote to Dr. Bliss:

Volta Laboratory
1221, Connecticut Avenue
Washington, D.C., *July* 31, 1881

My dear Dr. Bliss:

I write to let you know that my new form of Induction Balance gives brilliant promise of success. The indications with a flattened bullet are well marked and, distinct at a distance of three inches, and audible effects can even be distinguished at five inches, but beyond three inches silence and the greatest attention are requisite. Effects are produced at about two inches, when the bullet is held with its edge towards the instrument — a position that gave no results with our former apparatus.

Altogether I feel very much encouraged. The apparatus in its present form is a very clumsy affair, the surface that would be applied to the person of the President measuring seven inches by four. I hope to reduce the size of the apparatus very greatly in a day or two. In the mean time, should any necessity arise for an experiment upon the President, we have much better chances of success than at any previous time.

Yours very truly
Alexander Graham Bell

In reply to this, Bell was asked to make another attempt on Monday morning, August 1st. Although the official bulletins treated the test as successful and the newspapers ran accounts of 'The Wonderful Bullet Seeker,' Bell felt that nothing positive had been ascertained. He was puzzled by a faint buzzing sound noticed over a wide area. The next morning he called at the White House to enquire of the physicians whether they were perfectly sure that all metal had been removed from the bed on which the President lay. It was revealed that underneath the hair mattress was another composed of steel wires. Bell called it a steel mattress. It was probably a

spring. He was to conclude later that it had not been the cause of the inconclusive result of the experiment, but this neglect of the White House physicians laid him open to mortifying criticism at the time. Bell never did anything in his life with less thought of personal advantage, and never anything for which he was more widely ridiculed than for these experiments designed to save Garfield's life. He suffered acutely in hot weather, yet he worked through sleepless weeks in the torrid malarial city, with only one purpose in view — to find the bullet before it was too late. Publicity-seeker, his enemies said. The hostility of rival claimants to the telephone was at its peak (Daniel Drawbaugh's absurd claims had been capitalized by a ten-million-dollar company), and this blunder of the steel spring was a weapon to their hand to discredit and lampoon Bell.

Nevertheless, he persisted in the effort to perfect the apparatus, and when Bell was called out of the city Tainter continued the work alone. August was in its third week when the President had a relapse, special prayers were resumed in the churches, and by the time further improvements had been made in the exploring coil his condition was too grave to permit further tests. He rallied sufficiently to be removed in early September to Elberon, New Jersey, but his death on September 19 and the subsequent *post-mortem* examination proved that the bullet had been too deeply embedded to have affected the balance in the tests made.

(4)

The apparatus was perfected, however, and successfully applied early in October, in New York. Army officers having Civil War bullets in their persons, veterans of Gaines' Mill and Cedar Mountain, presented themselves for the tests, which were made under the ægis of Dr. Frank H. Hamilton. Dr. Hamilton had been consulting surgeon in attendance on the President, and had been appreciative of Bell's disinterested efforts, and evidently sympathetic during the ridicule that ensued. Now he invited twelve other physicians to be witness to this triumph.

From this sojourn into the medical field, Bell emerged also with his telephone probe, a means which he had also communicated to the surgeons in attendance on Mr. Garfield. The apparatus was intended to be used only as a preliminary to an operation for the extraction of a bullet. It consisted of a fine needle, attached by a wire to one terminal of a telephone, and a metal plate attached to the telephone's other terminal. The plate was to be placed on the patient's skin while the needle was thrust into the body where the bullet was thought to be lodged. Contact of the needle with the bullet completed the circuit through the patient's body and was registered by a click in the telephone. Several years later the University of Heidelberg bestowed its rare honorary degree of M.D. on Bell for his contribution to surgery in this device.

While in Europe that autumn, when he was made an *officier* of the French Legion of Honour, Bell presented a paper on his telephone probe to the French Academy of Sciences. The following summer he read

a paper at the Montreal meeting of the American Association for the Advancement of Science, 'Upon the Electrical Experiments to Determine the Location of the Bullet in the Body of the Late President Garfield, and upon a Successful Form of Induction Balance for the Painless Detection of Metallic Masses in the Human Body.'

In November, that year — 1882 — the Supreme Court of the District of Columbia admitted him to American citizenship.

CHAPTER XVIII

(1)

UNTIL the late nineties, Bell was never wholly free from the demands of counsel in his company's long fight against infringers. Year after year he was summoned, sometimes from abroad, for cross-examination on all the old evidence. It is obvious that Bell was his company's trump card. Many years later, a distinguished lawyer, who had been then retained by rival interests, was to relate the profound impression Bell's evidence always made in court. No one who heard him on the stand could doubt his complete honesty, and his insistence on answering questions to which his counsel objected — sometimes resulting in admissions of which the opposition made good use — while embarrassing for his lawyers, only confirmed the impression of Bell's truthfulness.

During the early eighties he began his researches in the heredity of deafness, established an experimental private school in Washington, was prime mover in establishing the weekly Journal *Science*, and with Chichester Bell and Sumner Tainter continued the experiments of the Volta Laboratory.

(2)

The work of the Volta Laboratory Association was to result in the invention of the first successful phonograph record, an invention which, oddly enough, was to do far more for the commercial

success of Edison's phonograph than Edison's transmitter did for the telephone.

Edison's talking machine of 1878 operated with a tin foil cylinder, on which the record had been indented with a blunt instrument in a sort of hill-and-dale impression. The reproducing device hopped along from one hole to the next, resulting in speech or music that was recognizable rather than clear, and, wonderful as it was, the machine had no commercial value. It is still in the National Museum, as are the Volta Laboratory records which were to make all phonographs articulate.

The Volta Laboratory Associates had set out to make a machine that would both record sound and reproduce it, so they called it a phonograph-graphophone, since it was both a sound-writer and a writing-sounder. But the term was clumsy, it was abbreviated to graphophone and this name stuck.

The record was their triumph.

Out of their accurate knowledge of sound the Associates evolved a cylinder with a waxy surface, having an engraved record made with a sharp cutting tool, instead of an indented record made with a blunt tool, and bearing the record in a zigzag, or laterally undulating form, rather than in Edison's hill-and-dale fashion. The difference in the methods was nearly as great as the difference between a make-and-break and an undulatory current of electricity, and it reproduced sound smoothly instead of by jerks.

The Associates followed their cylinders by the invention of the flat disc record, the form that is now in universal use. The earliest of these, made flat

with the idea that they could be mailed conveniently, were intended to substitute verbal for written messages through the mails. Joint work though this all was, and though one of the most important patents was taken out by Chichester Bell and Tainter alone, this idea of sending conversation by mail bears the unmistakable imprint of Graham Bell's imagination.

CHAPTER XIX

(1)

The story of Graham Bell's work in behalf of the deaf should have its own book.

A teacher by temperament, a teacher of speech to the deaf by training and circumstances, Bell's interest in the education of the deaf was to become deepened and strengthened into one of the passions of his life. He was to battle for the privilege of speech for deaf children with the same zeal and burning belief that carried him through many causes, but none more near to him than this. The cause and his own work for it were to be so interwoven with Bell's whole life that they cannot properly be given their place by years, and chapters, and dismissed, as the telephone and photophone can. Undoubtedly his wife's and his mother's deafness were in part responsible.

(2)

When Bell came to the little Boston school in 1871, there were only four speech schools in America, with a total of a hundred and forty pupils, where a deaf child could be taught to speak or to read the lips. Not that speech-teaching was a new thing — it was common in Germany and Italy — but because the De l'Épée language of signs, a system of conventional gestures, had been introduced in the United States early in the century, and teachers trained in the first sign school had gradually

brought it into country-wide use. Gestures took the place of speech with the American deaf.

To most persons, deaf-mutes were one with the feeble-minded. And even when this idea was not held, it was rather vaguely supposed that deaf people could not speak because their vocal organs were defective. Their habitual use of signs did nothing to dispel the misconception. Few persons understood that speech is acquired by imitation, and that most deaf children are dumb only because they cannot hear. No one can, automatically, speak a language that he does not hear. Did any person suppose, Bell would ask, that there was anything the matter with his own vocal organs because he couldn't speak Chinese?

But, although speech-teaching was not new, when Bell began his Boston career even articulation teachers had no clear idea of what positions their vocal organs took in speaking, and it was Sarah Fuller's realization of the value of Visible Speech as an aid to speech teaching, and Bell's inspired adaptation of his father's symbols, that gave speech its first great impetus in American schools for the deaf.

Though he knew that deaf persons could be taught to speak, at the outset Bell was admittedly sceptical of the possibility of teaching them to read speech from the movements of the lips. And although he was soon to become convinced, he first set himself to his now historic effort with the phonautograph to enable his deaf pupils to see the language that they could not hear, an effort that led to the electric speaking telephone.

The use of Visible Speech as an aid to articulation

teaching was an immediate success, but some of Bell's innovations in teaching methods were received with rather more reserve.

There was, for instance, his insistence that language should be as constantly addressed to the eye of a deaf child as it is to the ear of a hearing child, and that, therefore, the deaf child should be encouraged to read and write before he could comprehend what he wrote or read! To the bewilderment of his teachers, Bell insisted that hearing children heard spoken language long before they could understand it, and that it was just as important for a deaf child to become familiar with the way words looked as for a hearing child to get used to their sound.

More startling yet was his belief in the value of dancing and music for the sense of time they gave, and the value of nursery rhymes for a sense of rhythm. He counselled teachers of the deaf to study Mother Goose, to learn the rhythm that appealed to hearing children; it was the rhythm, he said, and not the sense of 'Hickory, Dickory, Dock,' that children liked. He found that little George Sanders was enchanted with an exercise given him, and repeated it over and over, 'of a *pa*, of a *ba*, of a *ma*.' He made games of his word-lessons, talked to deaf children as though they could hear, and gave his little pupils toy balloons to hold, so that they might feel the vibration of his voice when he spoke near them. It is all very commonplace now, but it was all very hare-brained to the general teaching profession fifty years ago.

Bell had a profound sense of the injustice that was being done the large number of partly deaf

children who had not enough hearing to enable them to be educated in public schools, and who were thus sent to institutions for the deaf, and taught to think and communicate in a sign language, and this by teachers who were often deaf themselves, until the children lost even their dim recollection of speech. Parents of small means had no choice in the matter, and a sign language was better than nothing at all.

'I have seen a boy who became deaf at twelve years of age,' Bell once said, 'and who had previously attended one of our public schools, go into an institution for the deaf and dumb, talking as readily as you or I, and *come out a deaf-mute.*' A young man who had been educated at a sign-language institution, and who was later taught to speak and to read the lips, told Bell that he had been able to hear people talking in the workshop where he was employed, but didn't understand what they said.

Bell felt the isolation of these children as poignantly, and fought as passionately for their release, as the average citizen would feel for their physical captivity.

Once, speaking at a convention in Chicago, he lost himself in the ardour of his appeal, and talked on through the luncheon hour, past the hour, until, when at last he sat down, his famished and exasperated audience dismissed his motion and adjourned for food. For years, 'Remember Chicago' was a rueful household jest.

Bell's own active teaching was over in the seventies, but, with the larger means and leisure of the next decade, he began his researches in the causes

and heredity of deafness, and began his active leadership in the movement to give every deaf child the opportunity to use language, instead of signs, to the avowed end that 'dumbness among the deaf, like illiteracy among the hearing, will be considered as a mark of defective education.'

The sum of it all should make his name remembered as an educator even if he had never done anything else.

(3)

It is a commonplace that deafness runs in families.

Soon after 1878, Bell began an elaborate scientific investigation to ascertain the cause of congenital or family deafness. He noticed that large percentages, sometimes half of the pupils in an institution or 'asylum,' had deaf relatives.

As he could not hope to pursue a country-wide enquiry of such scope, he confined himself to New England, and for four years the collection of material went on. He employed expert genealogists to collect information relating to families in which deafness occurred, and in this Bell had cordial coöperation from many of the families concerned; he purchased published histories and family genealogies and a mass of valuable unpublished genealogical material. His own labour was prodigious, and not until 1883 was all the information compiled and tabulated.

An analysis of it brought Bell to a startling conclusion. He found that, proportionally, the deaf-mute population was increasing more rapidly than the general population, and that the number of deaf-

mute children of deaf-mute parents was increasing at a rate still more alarming.

He found the cause, he thought, from a study of reports of institutions and asylums, which showed that an increasing percentage of former pupils were intermarrying. And he was forced to the disquieting deduction that if this condition continued unchecked, and 'if laws known to hold in the case of animals also apply to man, intermarriage of congenital deaf-mutes through successive generations should result in the formation of a deaf variety of the human race.'

Where he had previously felt that language was an inalienable right, not to be denied any child capable of understanding it, he now felt that language-teaching was all that could stay the development of an intensified hereditary defect, along with its shocking consequences to the race.

The obvious root of the condition, as he showed, lay in the custom of separating deaf children from hearing persons early in life, making them live together in the same place until adult life, and, most of all, in teaching them to communicate wholly by signs not understood by hearing persons, so that they were cut off from ordinary human contact, excepting with other deaf-mutes.

Naturally, after their school life, these speechless pupils sought each other out for companionship, formed themselves into societies for social intercourse, held reunions — and ultimately, many of them, intermarried.

If educators and philanthropists had intended to produce this result, as Bell pointed out, they could not have gone about it any more adroitly.

He urged the creation of day schools for the deaf, which would permit deaf children to remain in their normal environment, grow up in a hearing atmosphere, and form friendships among hearing persons. Only in this way, he argued, could they be expected to marry hearing partners and thus reduce the likelihood of having deaf children.

The conclusions of this study were presented by Bell at the New Haven meeting of the National Academy of Sciences in 1883, and published that year under the rather unfortunate title of 'Memoir on the Formation of a Deaf Variety of the Human Race.'

It roused a storm of opposition from sign-language adherents, and then — as Bell used to tell — a newspaper reporter happened to pick up a copy of the pamphlet in the office of a member of Congress, and, glancing hastily at the title, gave it to the world that Alexander Graham Bell was memorializing Congress to prevent the deaf from marrying!

This error created much hostility to Bell among deaf persons who never read the memoir, but the study itself attracted wide and serious attention.

(4)

These researches into the inheritance of deafness ran parallel with the work of the Volta Laboratory Associates, and when their Washington headquarters was moved to the Georgetown section of the city, Bell set aside part of the new building for his statistical work. The laboratory was a little two-storey brick building, set in the rear of the Melville Bell house, and fronted on Q Street in the block since known as Volta Place.

As the volume of his correspondence grew, Bell's research assistant, John Hitz, suggested that two addresses should be adopted, Volta Laboratory for the experimental work, and Volta Bureau for the growing correspondence on the deaf. Later, when the Volta Laboratory's graphophone patents were sold, Bell put his share of two hundred thousand dollars into an endowment fund to continue the new 'Volta Bureau' — 'for the increase and diffusion of knowledge relating to the Deaf.'

Later, when the conclusions of Bell's 'Memoir' were challenged by Dr. Edward Allen Fay, editor of the *Annals of the Deaf* and an authority on the subject, Bell offered — through the Volta Bureau — to finance the collection and publication of material for any study which Dr. Fay wished to undertake to disprove his own. This resulted in Fay's 'Marriages of the Deaf in America,' which showed that in the case of the congenitally deaf Bell's fears were only too well justified.

(5)

A valuable by-product of Bell's researches into the heredity of deafness appeared in 1885, when he published in *Science* his paper, 'Is There a Correlation Between Defects of the Senses?' During his studies of family deafness, Bell had been struck with the number of feeble-minded children born in families of deaf ancestry even when the hereditary deafness did not appear. His study of the census returns confirmed this apparent connection between the two defects.

This time, by the query, he disarmed attack.

'People sometimes assume,' he said, 'that a defect of any important sense is balanced to the individual by the increased perception of the remaining senses. For instance, it is often thought that deaf persons have better eyesight than those who hear, and that blind persons have better hearing than those who see. The returns of the Tenth Census of the United States (1880) concerning the defective classes show clearly the fallacy of such a belief. They indicate that the deaf are much more liable to blindness than the hearing, and the blind more liable to deafness than the seeing.'

He supported this very significant conclusion by the evidence of seven tables, presenting in detail a careful analysis of the total defective population — then upwards of two hundred and forty-six thousand persons.

'The tables seem to indicate,' he continued, 'that in the case of deafness, blindness, idiocy, and insanity, some correlation exists; for persons having one of these defects appear more liable to the others than persons normally constituted, and doubly defective persons appear to be more liable to be otherwise defective than persons having a single defect.'

There were, he found, fourteen and a half times as many blind and forty-six times as many idiotic persons among the deaf and dumb in proportion to the population as there were in the community at large, fourteen times as many deaf-mutes and nineteen times as many idiots among the blind, and forty-three times as many deaf-mutes and eighteen times as many blind among the idiotic, as there are among the general population.

It was a staggering result, and brought him to the conclusion that 'the apparent correlation between deafness, blindness, and idiocy may possibly indicate that in a certain proportion of cases these defects arise from a common cause, perhaps arrested development of the nervous system.'

A leading medical journal republished the article in full.

Unfortunately, he never carried this enquiry further. The later telephone litigation effectually interrupted all this work of research, which Bell never resumed. But brief as it was, it resulted in one great reform.

Bell's study of the Census had revealed the very inadequate returns on the deaf population, and led to his vigorous campaign to effect a change. His efforts resulted in improved forms, used in the Census of 1890, and when he was asked to act as special agent in charge of the census of the deaf in 1900, Bell accepted the task rather than have the work of years lost. It was due to his untiring efforts that, officially, the term 'deaf' supplanted 'deaf-mute,' and his progressive influence in having the deaf removed from the defective classification is nowhere more clear than in the official designations of the three Census reports which concerned the deaf population, the first compiled before his active interest began, and the last his own work:

1880. Report of the Defective, Dependent and Delinquent Classes of the Population of the United States, as returned at the tenth Census, June 1, 1880.

1890. Report on the Insane, Feeble-Minded, Deaf and

Dumb, and Blind, in the United States at the Eleventh Census, 1890.

1900. Special Reports: The Blind and the Deaf, 1900.

In 1888, Bell was invited to appear, and gave lengthy evidence before the Royal Commission appointed by the Government of Great Britain to enquire into methods of education for the deaf. After three years' deliberation on evidence gathered from all parts of the world, the Commission recommended — 'That every child who is deaf should have full opportunity of being educated on the pure oral system, to speak and to read the lips.'

CHAPTER XX

(1)

THE Bell family planned a holiday in 1885.

For a long time Melville Bell had wanted to revisit the scenes of his young manhood, and that summer Graham Bell, his wife and two small daughters set out with him to Newfoundland. While they discussed routes of travel, Mr. Hubbard suggested that the party might travel by way of Cape Breton Island, at the northern tip of Nova Scotia, and take a look at the Caledonia coal mine at Glace Bay in which he had invested.

And so it fell out that instead of taking a steamer direct to Newfoundland they broke the journey with a détour into that lovely island and its inland sea, the Bras d'Or Lakes, on their way to the coal mine and the port of North Sydney from which they were to sail for St. John's.

The term 'Lakes' is a misnomer for the Bras d'Or. To begin with, the water is salt. It is really a branch of the ocean. Its four hundred square miles of area, widening out from two narrow Atlantic entrances, ramifies the land in a hundred bays and channels so that one may follow along a thousand miles of interior coastline. Some one has aptly said that in Cape Breton Island the old definition is reversed. It is water surrounded by land.

Ten years or so before, Charles Dudley Warner and a companion had found their way into that beautiful country, and Warner had written a book

around the journey. When the Bell party passed through the Bras d'Or Lakes on their way to Glace Bay their steamer stopped at Baddeck, and, because he had read Warner's book, Graham Bell strolled up the road to find the 'unhotel-like appearing hotel,' the Telegraph House, with its flower garden and hospitable lights, and to call upon Mrs. Dunlop who had welcomed Charles Dudley Warner.

The Bras d'Or Lakes, and particularly Baddeck, enchanted the Bell family as they had enchanted Warner, and later, when the party met shipwreck on the way to Newfoundland, and were brought back to Cape Breton without reaching St. John's, they returned to Baddeck and the Telegraph House. It was the first of the long visits which were longer with every year until Cape Breton became their permanent home.

(2)

The Bell family had not returned from Cape Breton when, in September, 1885, a new and especially notorious telephone suit burst upon the public. On the application of the Pan-Electric Telephone Company, whose backers were already under injunction for infringing the Bell patents, the office of the Attorney-General at Washington brought suit in the name of the United States against the American Bell Telephone Company and Alexander Graham Bell, in the attempt to annul the Bell patents.

Added to the old familiar faces of prior inventors, this suit brought against Bell the new and night-

mare visage of perjury and fraud, of collusion and bribery of Patent Office officials.

The instigators of this attack, the Pan-Electric Company and its subsidiaries, had been incorporated under the laws of Tennessee to exploit the telephonic and telegraphic inventions of a young gentleman named Harry Rogers, who had been appointed electrician of the House of Representatives some years earlier by the Honorable Casey Young, then member of Congress from Tennessee. The idea of the Pan-Electric venture had originated with Harry's father, Dr. James W. Rogers, who very naturally enlisted the aid of the family patron, Mr. Casey Young, in patenting and developing his son's inventions. Mr. Young had interested a group of his friends, and the company was incorporated with five million dollars capital, of which sum only four dollars and fifty cents was required to be paid in for the use of the State seal. And so, with everything to gain and four dollars and fifty cents to lose, the Pan-Electricians, sitting well in order, embarked on that glittering quest of the eighties, the search for a way to break the Bell patents.

In their application to the Attorney-General, they took their departure from the premise that Reis had invented the electric speaking telephone, and that Bell knew it and concealed his knowledge from the Patent Office — and of course from Joseph Henry, Sir William Thomson, and the judges of the Centennial! This was fraud number one. It was further charged that Bell's attorneys, Messrs. Pollok and Bailey, had connived with the Patent Office officials to obtain dishonest knowledge of Gray's ca-

veat; that they had stolen Bell's specification, rewritten it, and returned it to the file; that Bell, then in Boston, came back to Washington the following week, approved of this felony, so becoming party to it, and went to the Patent Office to interlard even more new matter — all derived from Gray's caveat — making the old parts conform to his attorney's interpolations; and that several years later, fearing discovery of the crime, Messrs. Pollok and Bailey had stolen the whole document and substituted an entire new one to conceal all these changes! This last giddy naïveté was designed to anticipate the obvious retort that Bell's original application could be produced from the Patent Office files and shown to have none of these alleged interpolations and changes in it.

All this — charges of the gravest kind — the office of the Attorney-General passed upon within twenty-four hours, without even the usual formality of referring the papers to the Secretary of the Interior or his Commissioner of Patents, and suit was brought, immediately, with the weight of the United States Government as plaintiff, in an attempt to fasten on Bell 'the infamy of having perpetrated the most gigantic fraud of the century.'

The precipitance of the whole move was the more surprising since the Bell patents had been repeatedly sustained by Circuit Court decisions, and several appealed cases were then awaiting decision in the United States Supreme Court. The value of this speed, to the Pan-Electric Company, was plain, however, when a suit of the Bell Company against a Pan-Electric subsidiary came up for hear-

ing in Baltimore on September 15, and the District Attorney appeared on behalf of the United States, protesting against any hearing of the Bell motion for an injunction until the Government suit could be concluded. In effect, this gave letters of marque to the Pan-Electric to prey upon the Bell interests indefinitely. Further, the Government suit was not brought in the District of Columbia, where Bell lived, nor in Massachusetts, where his company operated, but in Tennessee, where Bell had never been and where his company had never had an office.

Even Bell's critics admitted that there was something a little odd about the proceedings.

(3)

The Pan-Electric concern was soon exposed for the stock-jobbing swindle that it was, but the complete assurance with which its suit was brought is its own comment on the high hopes which its authors entertained for its success. And the infamous nature of the personal libel on Bell tells its own story of the impunity with which his reputation could be safely attacked in 1885.

At this time the Bell Company was enduring the odium of its alliance with the Western Union and Jay Gould. It was heir to the calumnies of eight years of the bitterest patent litigation in history, and it was beginning to acquire an unpopularity of its own as an oppressive monster of monopoly. A moderate contemporary, in sweeping censure of the Government suit, still said: 'Nobody is very anxious to help the Bell telephone, and the public

generally would no doubt welcome some restriction of its privilege if satisfied that such a restriction were legal and just. Nobody would mourn over its misfortunes. It is recognized as an exacting monopoly, charging enormous prices for a service that is often indifferent.'

But if the telephone company had few friends to champion its wrongs, there were any number of persons alert to scrutinize the strange solicitude of Mr. Cleveland's Attorney-General for the rights of a supposedly defrauded people. Notably there was the Republican press Argus-eyed for scandal in an opposition administration.

On September 25, the New York *Tribune*, the contemporary quoted, threw the first light on the Government alliance with the Pan-Electric. On that day the *Tribune* printed a startling story on its front page stating that Mr. Garland, the Attorney-General, was not only a large stockholder, with shares totalling a million dollars, in the Pan-Electric Company, but had been the company's attorney and legal adviser since its organization. The list of principal stockholders ultimately disclosed read like a page from a Government Blue Book. Besides the Attorney-General, the list included the Administration's Railroad Commissioner, the Indian Commissioner, three United States Senators, three ex-members of Congress, and an ex-Governor of Tennessee. It appeared that these guardians and ex-guardians of the public trust had substantial personal motives for their judicial anxiety to wrest the rights of the people from the perfidious Mr. Bell.

From this point on the fight became more political than legal or industrial. The *Tribune's* story was carried in one form or another by all the New York papers, with the exception of the New York *Times*, which had abandoned its old Republican allegiance to support Cleveland the year before, and editorial comment reflected their several policies, ranging from the Republican *Tribune's* vigorous suspicion to the Democratic *World's* stout faith that Mr. Garland's skirts were clear.

The Attorney-General's friends rallied to his defence. He had been absent from Washington, shooting deer in Arkansas, far from the reach of telegraph or telephone when the Pan-Electric application had been made, and obviously was not responsible for the official step of his Department. When he returned to the Capital, they said, he would doubtless issue a statement silencing the malicious rumours of this ridiculous million dollars of Pan-Electric stock.

Mr. Garland returned and disclaimed any responsibility for the suit. The application had been allowed by the Solicitor-General after he, Mr. Garland, had left for his holiday. But he admitted ownership of the Pan-Electric stock. The admission brought a country-wide storm of criticism. Demands were made for 'a full and complete explanation,' and, the comment of a dozen papers ran, 'until it is forthcoming the Department of Justice must remain under the grave suspicion of having used the powers of the public office to promote the Attorney-General's private speculations.'

Altogether it was the Teapot Dome of its day.

While the more rabid of the Republican papers were demanding Mr. Garland's resignation, Dr. James Rogers rushed into print with a well-intentioned but damaging letter, disclosing the fact that an earlier application had been made to the Attorney-General in person, and that he had declined to grant it because of his own private interest in the issue. A little pompously, Dr. Rogers corrected the statement of the press that Mr. Garland had a million dollars' worth of the Pan-Electric stock. His shares amounted to a million and a half!

Mr. Garland must have felt, with Samuel Butler, that if it wasn't such a terrible thing to say about a person, he would say that he meant well. This unnecessary statement from Dr. Rogers, intended to vindicate the Attorney-General, only added to his troubles. The opposition newspapers made the most of the fact that he had been approached in the matter and had declined to act; that he had left Washington soon after, and that the application had been renewed as soon as he was out of the city; that the Solicitor-General acting in his absence had granted it within twenty-four hours, and without submitting the papers to the usual departmental delays. Mr. Garland's opponents said that he had gone a-hunting the wild deer and a-following the roe in Arkansas to permit the suit to be rushed through without his participation, and so was accessory to the conspiracy; his defenders said that it was all a coincidence. Altogether the situation began to assume the proportions of a public scandal, the more embarrassing to Mr. Cleveland because his

administration had just come into power on a platform of reform, pledged to correct the abuses of the bad old days of Grant.

Mr. Garland wrote a letter to the President reciting the circumstances, saying that the application had been allowed by the Solicitor-General, and that he had had nothing to do with it. The President wrote to the Solicitor-General asking for an explanation, and the Solicitor-General wrote back to say that everything was entirely regular and proper, but that he had, neverthless, withdrawn the suit.

There the matter might have dropped, but the fat was in the fire. The newspapers refused to be still, and since Mr. Garland did not resign, and the Administration stoutly maintained his official innocence, there was nothing to do but to go on with the suit. The Pan-Electric application was referred, for an opinion, to the Secretary of the Interior, to whose department it should have gone in the first place.

(4)

Bell returned to Washington early in October to find himself the target of the Pan-Electric's startling and outrageous charges, and, with characteristic directness, immediately wrote an indignant and emphatic denial for the press.

Writing was not Bell's medium of expression, but, progressing by tedious rewritten drafts, he could and did express himself with great clearness and force. He had not needed a lawyer to phrase his patent specification, though it stands as a model

of lucid and exact English, and he did not need legal or literary aid now to write to the newspapers in vigorous and explicit denial of the Pan-Electric charges. He showed the letter to his lawyers before he sent it, however, and they flatly refused to let it go. No matter what knavery was charged against him, no matter what libels the newspapers printed, he was told, he must keep silent. His defence must be made in court.

This was the same Bell who had wired furiously to Elisha Gray in 1877, the same Bell who had walked out of his house in Boston and brought a policeman in from the street to confront a gossiping servant with some idle slander; and he had yet to learn — with Leonardo da Vinci — that it was not sufficient to reveal the truth to men to have them accept it. He could not endure this widespread defamation in silence, and he fought the issue bitterly with his counsel, Mr. Storrow. Bell learned now that he was no longer an individual; that attacks on him were attacks on his company; that so far as the public was concerned he was the company, and that his defence was his company's defence. Ultimately, he bowed to his counsel, so far as the newspapers were concerned, but he stood on his determination to send a formal letter of protest to the Attorney-General. He wrote it, and later had it printed in a pamphlet of nineteen pages. No counsel's brief ever stated Bell's case more clearly than this letter. He began:

WASHINGTON, D.C.
October 25, 1885

To The Hon. A. H. Garland,
Attorney-General of the United States.

SIR: I live in Washington, within a few minutes' walk of your office, and have resided here for several years. I think you know this.

An instrument which I have furnished to science and the arts has made my name widely known.

I have asserted, and again assert, that I am the first inventor of it. I have received honours which would not have been bestowed had not that assertion been believed; and when my rights have been invaded, the courts of the United States have affirmed the truth of my claim and the validity of my patent.

Three weeks ago I returned from a long journey and found every newspaper proclaiming to the world, on the authority of your Department, that my assertion that I am that first inventor is false, and has always been known by me to be false; and that the patent which the United States granted to me for the invention was obtained by false and fraudulent suggestion and concealment on my part. I find myself charged by your Department with perjury and fraud.

This charge, the newspapers inform me, was made in a suit brought, not in Washington, where you know I reside, nor in Massachusetts, where the Company which is the sole owner of my patent has its domicile — but in Tennessee, where I never have been, and where the owner of my patent has not even an office or an officer.

The suit was brought at the instigation of convicted infringers of my patent; the counsel appointed to prosecute it are their counsel; and its pendency was announced by a United States District Attorney at Baltimore, as a reason why a United States Court there should not hear, against one of those infringers, a motion for injunction which it had previously ordered to be heard.

The infringer, which so attempts to use this action of your Department, to shield itself from judgement, is a

corporation of which you were one of the organizers, one of the largest stockholders, director, and counsel.

I seek for some explanation. I find that the explanation you gave was so far from sufficient, that upon it alone the suit was instantly dropped. But the very letter of the Solicitor-General, which announced that the suit was withdrawn because the charges were made without proper examination, reasserted them.

I deny every one of these charges. The official records absolutely disprove them. I propose to call your attention to those records.

With equal restraint and precision the letter went over the whole ground of the Pan-Electric's flimsy charges, and concluded:

I am not blind to the real character of the proceeding sanctioned by your Department. It was not your personal act. It did not even originate with your Department. It was due to convicted infringers. There is reason to fear that they hoped the influence of your known personal interest would make action more speedy and scrutiny less careful. Plainly a proper examination would have defeated their scheme.

I know that the official order was given by the Acting Attorney-General (Solicitor-General) while you were absent from Washington. But the facts remain that you knew of the first application and expected its renewal; that the action was unusual, taken with extraordinary haste, without time for suitable examination, without the usual reference, in the face of repeated decisions of the courts, in spite of absolute disproof from the records; that it selected a forum unlawful and oppressive; that it was in substance (in part at least) of a corporation in which the head of the Department had an enormous interest, urged by the personal presence of your co-directors, and instantly (though unavailingly) employed in the attempt to protect that corporation from a trial where each allegation, *if true*, would be a defence for it.

I have no fear that my recognized position as the inventor of the speaking telephone will be impaired in the estimation of scientific men and the world at large by the attack that has been made upon me; but I have not the philosophy to endure with patience the accusation of fraud and perjury brought against me in the name of the Department of Justice of the United States, even though the Patent Office which granted my patent, and the courts which have sustained it, are included in the accusation.

I have, therefore, made this statement of facts to be filed in the records of your office.

I am, sir, yours respectfully

ALEXANDER GRAHAM BELL

(5)

It was still the era of personal journalism in the United States. Editors, as James Melvin Lee has pointed out, were practically supreme in their control, and people had for years bought papers to see what Horace Greeley wrote in the New York *Tribune* or Joseph Medill in the Chicago *Tribune*. Long after Greeley was dead there were up-state subscribers reading the New York *Tribune* for Greeley's editorials, which were then, in 1885, bearing the imprint of Whitelaw Reid.

In New York, Charles A. Dana controlled the *Sun*. George Jones and the *Times* were at the peak of the influence they had gained in the campaign against the Tweed Ring. Joseph Pulitzer had owned the *World* for two years, and had established the daily cartoon as a regular feature, with other policies considered fully as spectacular and in as bad taste; and Edwin Lawrence Godkin had been with the New York *Evening Post* for the same length of time, demonstrating his belief in a policy that was

the antithesis of Pulitzer's, and editing a paper for 'sober-minded people . . . instead of hollering and bellering and shouting platitudes like the *Herald* and the *Times*.'

Newspapers have never wielded more influence in the United States than these great papers wielded then and, with the single important exception of the New York *Times*, Democratic and Republican press alike made caustic criticism of the Government's suit. The *Times*, in loyalty to Cleveland, ignored the whole matter for some time, and only gave it prominence in January, 1886, when the decision of the Secretary of the Interior was made public. The Secretary decided that the suit should go on. Then the New York *Times* raised its mighty voice against Bell, and sustained it with a full-throated editorial chorus on the outrageous extortions of a greedy monopoly, with variations on the subject of Bell's 'fraudulently amended patent,' and the predatory Mr. Jay Gould. But the *Times* did not defend the Attorney-General. Late in January, it even commended the *World's* editorial in criticism of Mr. Garland.

The *World*, despite Mr. Pulitzer's presence in Congress on the Democratic ticket, and his support of Cleveland, now opened its pages to the whole unsavoury story of the Pan-Electric. Dana aired the matter with equal candour and courage in the *Sun*. By February, the newspaper uproar had reached such proportions that the Administration could not ignore it any longer, and a Congressional investigation was set on foot, by unanimous vote — 'Whereas, grave charges have been made, and

are constantly being made, by the leading press of this country reflecting upon the integrity and official action of certain officers of the Government of the United States.'

While the Congressional Committee was getting under way, the newspaper clamour against the Administration never flagged, and now the *Times* began to see sinister significance in the united and opposing front of the *Sun*, the *World*, the *Tribune*, and the *Evening Post*. It might concur in censure of Mr. Garland, but, so far as the *Times* was concerned, no good could come out of the Bell Telephone Company. Its editorial comment progressed from innuendo to open charges of bribery. 'The Pan-Electric scandal,' the *Times* said editorially on February 3, 'involving certain public men at Washington is a small matter in comparison with the Bell telephone scandal involving certain newspaper editors in the city of New York.' A second editorial of the same day on 'The Telephone Conspiracy' concluded, 'The public is fairly and fully warned of the designs of this extortionate monopoly. It may rest assured that this criminal and corrupt league of an insolent corporation with venal newspapers will not prevail.'

A few days later, it gave place on the front page to a statement that several New York newspapers were subsidized by the Bell interests, 'as much as $5000 being paid for a single article.' And on February 10, it flung its cumulative challenge in a long, passionate editorial. 'This case must be tried . . . in spite of the outcry kept up by certain newspapers in the pay of the Bell Telephone Company.'

Mr. George Jones was an able and an honest man, and one can only suppose, from the astonishing pages of his paper in these months, that he had convictions in this matter of the Bell patent. Perhaps the Bell Company of 1885 was the extortionate and greedy monopoly that he said it was. Perhaps Mr. Jones had an obsession in the matter of bribes, dating from his own refusal of five million dollars offered to him, in the hope that he would suppress the evidence against the notorious Tweed Ring. Whatever the motives behind the editorial policy of the *Times*, the result was to create and consolidate a public opinion that was flagrantly unjust to Bell. Other papers in other places took their cue from the *Times*. And Bell's counsel wouldn't let him open his mouth. It may have been good law, but it was a policy nearly unbearable to Bell.

Of all the baseless charges made against Bell in the long and determined effort to wrest the telephone from him, probably the most mischievous was the one alleging that he had stolen his ideas from Gray's caveat. Few people knew the difference between a caveat and a patent specification, and nobody read either one. There was nothing in Gray's caveat that Bell needed to steal, nothing in it that was not more fully covered in Bell's specification, written and sworn to before Gray's caveat existed. And besides, Gray never claimed to have formulated his idea in any way until he made a sketch on February 11, three weeks after Bell's specification was sworn to, and months after it was written. The amendment filed to Bell's application, which was the cause of so many shrill and suspi-

cious outcries, was simply a paragraph written at the suggestion of the examiner to avoid conflict with the language of a passage in Bell's own application for another patent of the year before. The amendment couldn't have been taken from Gray's caveat because it wasn't in Gray's caveat. But nobody read the amendment. Nobody read the caveat, or the application. Thousands of persons read the papers.

The charge of collusion between Bell's attorneys and the examiner of the Patent Office was to boomerang uncomfortably on Bell's opponents when the Patent Office files divulged the fact that, so far from favouring Bell, Examiner Wilber had written to Gray — outside of his duty and the office practice — telling him exactly in what particulars Bell's specification anticipated the description of his caveat. If Gray had wished to do so, he might have drawn up a specification from this information which could have been placed in interference with Bell's application. But he did nothing with his idea until after he had seen Bell's telephone in operation at the Centennial. Then, as he later testified, he tried to make an instrument from his own description, and it wouldn't work.

(6)

The Congressional investigation on the Pan-Electric scandal resulted in a printed record of over a thousand pages of closely set type. It is a rich piece of Americana, racy and authentic, a drama of the gilded age with its contemporary giants in speaking parts.

Joseph Pulitzer was the first witness called. He was questioned on the *World's* share in the newspaper publicity and testified that for months he had withheld the most damaging disclosures in the hope that the Administration would do its own house-cleaning. He was asked:

Do you own any of the Bell Telephone?
Mr. Pulitzer: Do I what?
Own any of the Bell telephone stock?
Mr. Pulitzer: I do not own any kind of stock in any kind of Bell or other telephone companies whatever. I do not know a human being financially connected with or interested in the Bell. No human being ever tried to influence me. As I stated in the beginning, I and I alone am responsible for the publication of these facts. I only printed the history after a hope entertained for three months that it might become entirely unnecessary, by the gentlemen in high official station getting rid of that stock.

It appeared that Dr. James Rogers was a poet. He had composed a long narrative poem on Jefferson Davis, and he had a natural longing to see his *opus* in print. Mr. Hutchins, proprietor of the Washington *Post*, testified that Dr. Rogers had offered him ten thousand dollars in Pan-Electric stock as a bonus for publishing some of his poetry, but Mr. Hutchins thought stock and verses 'very bad' and declined them both. During the rest of the hearing, the Rogerses, father and son, were referred to as 'poets,' and certainly in this suit they gave to airy nothings, if poets ever did, a local habitation and a name.

Whitelaw Reid, editor-in-chief, publisher, and principal proprietor of the New York *Tribune*, appeared and vigorously sustained his paper's policy. Charles A. Dana, summoned to explain

the attitude of the *Sun*, testified that he had for a long time declined to print the most flagrant disclosures because it seemed an attack on the President, 'a scandal most injurious, if true, to the Administration.'

Dana and Pulitzer, both Cleveland men — perhaps with the privilege of close relationship — spoke their minds more freely than any of the newspaper proprietors. Dana was asked, 'Your view then has been, I presume, that it would be improper for the Government to become a party to litigation looking to the revocation of a patent alleged to have been obtained by fraud?' and Dana flung back, 'When the question is one sure to be decided in the ordinary action of the courts, without the Government being a party, I see no reason for the President to be involved in it, and still less when the proceeding originated with a lot of deadbeats who ought not to be tolerated in any respectable political combination.'

George Jones, of the New York *Times*, came off rather less happily than the rest. He admitted that the *Times* favoured the Government suit, but declined to take the responsibility or to state which of his editors was responsible for any one editorial. To all these questions he replied, 'I do not think you have a right to go into the interior of my office.' He said that he had suspected a motive in the interest shown by the other New York papers, but admitted 'there may not have been any.' Altogether the charges of newspaper bribery fell rather flat. There was no evidence of a bribe offered or accepted. Mr. Jones had none to offer. And

then there was much laughter when the books of the Bell Company showed that the only payments made to any newspapers, throughout, were one of a hundred dollars to a trade paper, and one of twelve hundred dollars to the New York *Times*. This was for a four-column article on the Bell telephone which had appeared on January 1st, in a five-page section of the paper set up in news type, devoted to trade descriptions of various utilities, from sewing-machines to cures for deafness. Mr. Jones' opponents tried to make it all appear very heinous, and the *Sun*, its tongue in its cheek, ran a malicious editorial on the disclosure, entitled 'Funny,' but generally, everybody grinned. Very likely Mr. Jones did not even know that the article had appeared. Editors were editors then and not advertising managers, but it was all very awkward and made him look foolish.

Nevertheless, his paper returned to the attack on Bell with unabated vigour throughout the Supreme Court hearing of the case, until, in 1888, a decision favourable to Bell sent the case back to a Massachusetts court. The decision, considered a Bell victory, reached Bell in New Orleans. He had previously seen a reporter, who got from him the very characteristic statement that 'if opposition breaks down his patent, he will give up every cent that has come to him from it, and look about for a place to earn his living by teaching something.'

Ultimately the Pan-Electric case died a natural death and was dropped.

CHAPTER XXI

(1)

For several years the young Bells had been searching for that ideal summer place which they had finally found in Cape Breton in 1885. They wanted salt-water bathing, and hills and cool air; and they wanted it far from fashionable resorts, where they could live a simple, free life. All this they had discovered in Baddeck and its surroundings, and they determined to return the next summer and 'build a little cabin beside some running brook.'

So they wrote to Mrs. Dunlop, to ask her to recommend some resident who knew the countryside and could find the brook for them, and she suggested Arthur W. McCurdy. McCurdy, who afterwards invented the kodak tank-developing machine, was to become Bell's right-hand man and secretary, continuing in that rôle for years.

That summer of 1886, the 'suitable running brook' was not discovered, and an abandoned four-room cottage was rented, a mile or two out of the shire town. This little cottage, 'Crescent Grove,' which they later bought and enlarged, fronted on Baddeck Bay. Across the bay — perhaps a mile distant — several farms divided a noble headland which rose eight hundred feet from the water and stretched a mile or two south and west out into the blue lake. The red bluffs at its tip gave this jutting peninsula the local name, 'Red Head.'

Cape Breton reminded Graham Bell of Scotland, as it did many travellers.

MR. BELL AND HECTOR P. MACNEIL WITH HD MODELS

MR. BELL AND MACNEIL CONDUCTING EXPERIMENTS AT BADDECK

ALEXANDER GRAHAM BELL WITH HIS ASSOCIATE F. W. (CASEY) BALDWIN IN THE COCKPIT OF THE HD–4

BOW VIEW OF BALDWIN'S HD–4

Showing ladder-like arrangement of knife-blades on which she is supported. Baldwin at extreme right

In their exploring trips about the countryside, Bell one day rowed his wife across the quiet bay, and together they climbed to the top of the hill, as he used to climb Arthur's Seat and the Corstorphine Hill long ago. From a little clearing at the summit they could see a magnificent panorama of the Bras d'Or's shimmering reaches, and its blue encircling hills, range back of low range, fading into purple distances. They were enchanted with the view and determined to own the hill if they could.

Eventually they bought out all the farmers on the headland, but it took them seven years to do it. In the interval they built the 'Lodge,' as a temporary dwelling, a mile or two from the Point where they eventually built their permanent house. Bell designed the Lodge himself, and made a little cardboard model from which two local carpenters worked.

The Bells spent their summers there for four years, and one year stayed all winter at the Lodge, built for a summer dwelling though it was. When the weather was very cold, the whole family went out and ran up and down the hillside before breakfast to keep warm.

The hilltop was Bell's favourite haunt.

His late hours had now become a fixed habit. He read and worked until three or four o'clock in the morning, sleeping late the next day, and in these early Cape Breton years, after his work was done, he often climbed to the summit, up through fragrant hay-fields, through the thick, sweet, spruce woods, to the silent, starlit clearing. On nights of

summer rain he wore a bathing-suit for the climb, and a guest of '91 recalls a September gale when the wind fairly shook every one out of bed in the middle of the night, and the household gathered downstairs to find that Bell had gone for his favourite walk. He came back and tapped at a French window, 'dripping like a merman, and looking as handsome as an Apollo, with his gray curls wet and shining, and his white arms and legs . . .' Sometimes he made his nightly expedition by canoe, paddling out into the moonlit lake to the Point and back.

They all went on excursions by 'rig' and boat all over the island. A houseboat, *Mabel of Beinn Bhreagh*, was built and took the whole family off on holiday cruises about the Bras d'Or for weeks at a time. The *Mabel of Beinn Bhreagh* (perhaps an echo of the *Jane of Glasgow*) was afterwards hauled out on stone piers on a secluded bit of beach, and formed a retreat for Bell in which he was never disturbed.

While the Graham Bells were still at Crescent Grove, George Kennan and his wife, Emmeline Kennan, were their guests there one summer. Kennan, American traveller, author, lecturer — later famous as a special correspondent for *The Outlook* at one moment or another of world stress — was then best known for his investigation of the Siberian exile system. He was an expert on Russia generally, and had published his 'Tent Life in Siberia' long before. With Bell, he had been one of the Washington group who had founded the National Geographic Society under the general guidance of Gardiner Greene Hubbard, in the late eighties.

The winter after their Cape Breton visit, dining with the Bells in Washington, the Kennans heard that an adjoining cottage at Crescent Grove was for sale, and bought it forthwith by telegraph. They continued to be neighbours at Baddeck for many years, and that friendship was perhaps the one really close one that Graham Bell and his wife ever had.

One of the Dublin cousins, Charles Bell, had married a younger sister of Mabel Hubbard, and presently his family joined the group at Baddeck. They all camped and fished and swam together. Bell tied life-belts on the children, fastened a rope to the belt, and taught them all to swim. Bell's own swimming was not remarkable, but he could teach anything.

As more of the headland farms came into his hands, Bell built his first laboratory, a two-storey frame building on the edge of a little ravine near the shore. A spring farther up the hillside was dammed to supply water-power to run a small dynamo.

With McCurdy's advent in the rôle of secretary, Bell began to elaborate the type of dictation which his wife had once taken down for him. These notes were written in longhand in large bound notebooks, and carefully preserved. Night after night, half-reclining on one of the cots in the Lodge living-room, sometimes on the houseboat in quiet Bras d'Or harbours, Bell threw a rug over his feet, filled his pipe, and began: On the possibility of seeing by electricity; experiments to measure the light from fireflies; how to cure lung-strongle in sheep; the use

of radium in sealed glass tubes for the treatment of deep-seated cancers (1903); simple experiments to demonstrate elementary physics; condensing water from the breath; the use of rockets and gunpowder for propulsion; gravity the result of impact; remedy for certain kinds of neuralgic pain. The subjects, and his dictation of them, reflect his versatility, his wide reading, his vigorous, enquiring mind, his blind sides, his genius, his sublime egoism.

Bell had no intimates. These dictations were his substitute for discussion and argument. He was interested in too many things to be profound. And with that total lack of humour which is so often the concomitant of genius, he was obsessed with a tremendous sense of the importance of all his thoughts, however trivial, and their value to posterity.

(2)

By 1889, Bell had bought the hilltop and the clearing, and with them a flock of sheep.

Sheep were a new interest. Protesting ewes and rams were examined to satisfy Bell's abounding curiosity. He discovered that these simple creatures had no teeth in their upper jaws, that they had — usually — one lamb at a birth and that they suckled their young with two nipples. He was enchanted with these discoveries. For years he challenged people, 'How many teeth has a sheep got in its upper jaw?' Nobody knew. He wrote a paper for *Science* about it, and began:

> It is astonishing how ignorant we all are about common things. Just test the matter for yourself. Sheep are quite

common; and we are all more or less familiar with their appearance, and should therefore be able to answer some questions about them. Well, then, *How many front teeth has a sheep got in its upper jaw?*

You never counted them? You have not observed? Next time you come across a sheep, just look and see, and you will find that she has *none at all!* — the upper gum is bare.

We are all familiar with the fact that a sheep suckles her young; and know, therefore, that she possesses nipples that yield milk. How many nipples has she, and where are they located?

Human beings, of course, have only two, located on the breast. Dogs and cats and other mammals that have a litter at birth have many nipples, located in pairs all along the belly. Cows have at least four, located on the belly between the hind legs. Where are the sheep's nipples placed and how many are there?

With the discovery that they had two, Bell found also that some of the sheep had an extra, rudimentary pair of nipples. And that one or two of the ewes habitually bore twin lambs. He satisfied himself that there was a connection between the supernumerary mammæ and the twins. If ewes with four nipples had twin lambs, why shouldn't sheep be bred to develop six nipples, eight nipples, and to produce triplets, quadruplets — a litter at a birth?

The more he dwelt on this, the more Bell was convinced that the solution was only a matter of nipples. Dogs and cats had litters of offspring, and they had numerous nipples.

As enthusiastically as he had set out to contract space, as positively as he was to embark on the conquest of the air, Bell began to breed sheep to produce litters of lambs at a birth.

The local farms were canvassed for four-nippled sheep, and many a bleating ewe left neighbouring folds to fetch a fancy price from the Bell shepherd.

After some years of breeding these four-nippled sheep, a six-nippled stock was developed, and slightly over fifty per cent of the lambs born were twins. But the early objective of the litter was never attained.

Bell never dwelt on failures. He began experiments to determine the effect of feeding on the production of twins and on the sex of the lambs born, and he ultimately satisfied himself that both could be controlled.

For thirty years Bell's labours over these breeding experiments was prodigious. He worked out a system of earmarks; the sheep were elaborately catalogued by number and by a code description which indicated sex, colour, number of nipples, and whether the animal was single or twin. Births, weights, and matings were exhaustively noted and tabulated, and reduced to graphical diagrams. The results were communicated to the National Academy of Sciences. And though the mutton was tough, the wool inferior, and a farmer once complained that the local butchers declined to take them even as gifts, the multi-nippled, twin-bearing sheep did, ultimately, appear regularly in pairs.

(3)

In 1892, Bell acquired the last farm that separated him from his beloved hill top and the Point, and a permanent residence was built in an eight-acre meadow above the red bluffs. The view was magnif-

icent. The house was big and comfortable, with a wood-burning fireplace in every room, a great stone chimney, and an enormous fireplace in the entrance hall.

S. P. Langley, Secretary of the Smithsonian Institution, and Simon Newcomb, the great astronomer, were guests there together one summer, and assisted Bell in his efforts to discover why a cat always fell on its feet. It was to pass into local history that these three dignified and distinguished gentlemen, one on the verandah and two on the terrace below, stood for hours, dropping puss over the rail onto a pillow, watching her turn in the air and land on her paws. Helen Keller, the deaf blind child in whose education Bell had been consulted, had her first sea-bathing in the Bras d'Or waters off the Point rocks.

The estate was called 'Beinn Bhreagh' (a phonetic approximation of which would be Ben Vreeah), Gaelic for beautiful mountain (for Cape Breton's hills rise so abruptly from the water's edge that they give the impression of great height); but in the vernacular it is still 'Red Head' or 'Bell's.'

(4)

The upper storey of a warehouse on the place had a stage with a real trapdoor and a near-professional curtain; and Bell, with the gusto he brought to anything he did, directed his two daughters, then in their 'teens, and their cousins and their friends in amateur theatricals. He played the piano, with more vehemence and dash than accuracy, but with a zest and enjoyment that disarmed criticism. Bell's

critical appreciation of music, like his critical appreciation of most of the arts, was nil, but 'he knew what he liked.' He enjoyed music, and got vast pleasure from his piano. He stormed through Beethoven's Sonatas by the hour. He sang Scottish songs, with thunderous accompaniments, one might almost say, with gestures; and although his solo 'Laird of Cockpen' and his duet performance of 'Huntingtower' were classic, the best part of any song to him was the chorus with every one joining lustily in.

He read Shakespeare aloud in the evenings. He directed charades.

His urge to teach and his histrionic sense underlay it all. Conventionally, he cared nothing for the drama. The legitimate theatre bored him, and so did the opera, yet, consciously or unconsciously, Bell was a showman all his days. He was fearlessly honest and scornful of shams, but he had the showman's innate appreciation of an effect. The world was a stage, and his was a genius for entrances and exits. And it *was* genius. His long white hair and flaring white beard, his homespun knickerbockers and his old black tam-o'-shanter, his animation, and ample gestures, were the expression of a perfectly valid histrionic sense after a fashion that mere flamboyant affectations never are.

It was this *flair*, more than any editorial grasp, that prompted Bell to insist on putting pictures in the *National Geographic Magazine* when that periodical's life crept feebly from one annual deficit to another. The magazine was little more than a Society bulletin, distributed to less than a thousand

members — using occasional pictures and maps, it is true, but often with no relation to the text. Bell, then president of the Society, installed his young son-in-law, Gilbert Grosvenor, as editor, stood stoutly behind the new policy and for ten years paid its deficit until the magazine stopped losing money and began to grow.

The same quality underlay his dinner-table talk. Nothing was a commonplace to him. If an episode was not dramatic in itself, he made it so in the telling. He jotted down 'topics' on a bit of paper and carried it in his waistcoat pocket in case the conversation flagged — kidnappings, shipwrecks, stowaways, reunions after many years. It was, after all, the same instinct that guided Joseph Pulitzer's policy on the New York *World* — 'What is original — distinctive — unique — curious — odd — apt to be talked about.' Now and then Bell wrote short articles on natural phenomena, for which he transposed the letters of 'A. Graham Bell' to make the *nom-de-plume* 'H. A. Largelamb.'

When a young scientist sent Bell an article he had written on the dugong, or sea-cow, asking his comment, Bell wrote in reply that the article said nothing about the mermaid myth, which had arisen from the creature's habit of rising out of the sea carrying its young. It omitted any reference to the legend that the dugong shed tears, and that the Malays collected them in little bottles and valued them highly as a love charm. All these things, Bell wrote, doubtless seemed childish to the author's scientific mind, but they were points that would be apt to catch the public fancy.

Long before the vogue of the American comic strip, Bell advocated action pictures to tell a story without words, and once engaged a young artist to carry out the idea. He drew examples himself, and all his notebooks are illustrated by his funny little outline figures and diagrams. When any laboratory point seemed obscure, Bell commanded — 'Make a drawing.'

The blood of Alexander Bell, who once trod the Edinburgh stage, flowed impetuously in his veins.

(5)

Gradually, Beinn Bhreagh grew from its early informality into a small principality. Annual picnics for the workmen and their families grew into 'Harvest Home' fêtes, with races and games and prizes, with sandwiches and cakes by the cubic yard, boilers full of tea and coffee, and ginger ale by the barrel.

A house was built for the shepherd, one for a laboratory assistant, and another for the gardener. Gardens and lawns and ornamental trees were added. Roads were built. Wharves and boathouses, stables, a dairy and a windmill appeared. Departments and their superintendents were created. The gardener was elevated to 'Superintendent of Beinn Bhreagh Nursery'; the building foreman to 'Superintendent of Buildings and Wharves'; the farm became the 'Farm Department' and the farmer its 'Superintendent.' There was a good deal of overlapping, and the ratio of superintendents to workmen was rather high, but every one was happy, and gradually the family came to spend more and more time at Beinn Bhreagh, often — excepting for short absences — staying the year around.

CHAPTER XXII

(1)

For over ten years, beginning in the nineties, Graham Bell flew his giant kites above the windy hillsides at Beinn Bhreagh, trying to arrive at a heavier-than-air flying machine that should be efficient, stable, and safe.

The kite principle is the principle upon which all heavier-than-air flying depends. Every schoolboy knows that he keeps his kite in the air by holding it against the wind on a string, and, when there is no wind, that he can keep it aloft by running with it along a housetop or across a field to create an artificial wind. In a modern flying machine the running boy and his string are merely replaced by the motor and propeller driving it rapidly forward to create the supporting wind. Bell began to work, as he always did, from this first principle.

His work with tetrahedral kite structures was to come to nothing in itself, so far as practical flight was concerned, but out of it grew the important work of his four young associates in the Aerial Experiment Association, which was to mark a definite advance in aviation. Further, it initiated the use of pontoons for starting and alighting on water which was developed into the first seaplane. Most of all, in openly declaring his faith in flying at a time when mechanical flight was a subject of universal ridicule, Bell made a very great contribution to the art.

Bell's scientific repute had grown steadily since the bestowal of the Volta Prize. He had a well-established international reputation, and, in a period when the ultimate of impossibility was 'I could no more do that than I could fly,' he risked this reputation — no light thing for a man who had been through the telephone suits — in an open avowal of his belief that men could conquer the air.

How fully he risked it is plain from the remonstrance of the great Kelvin, who — as Sir William Thomson — had done so much for Bell's first fame. Lord Kelvin wrote to Mabel Bell in 1898:

THE UNIVERSITY
GLASGOW
April 20th, 1898

DEAR MRS. GRAHAM BELL,

I owe you many apologies for not having long ago written in reply to your letter of 29th September, which reached me in Philadelphia a few days before our departure for England. I was quite sure that your husband would not go on in respect to flying machines otherwise than by careful and trustworthy experiment. Even if the result is to demonstrate to himself that a practical useful solution of the problem is not to be found, I am sure what he finds by his observations and measurements will be very interesting, and I was much interested in all you told me in your letter regarding his experiments. When I spoke to him on the subject at Halifax I wished to dissuade him from giving his valuable time and resources to attempts which I believed, and still believe, could only lead to disappointment, if carried on with any expectation of leading to a useful flying machine.

Lady Kelvin sends her love to you and with my kind regards to your husband, I remain

Yours very truly

KELVIN

It was a time when, as S. P. Langley put it, 'a great many scientific men treated the whole subject with entire indifference, as unworthy of attention or outside of legitimate research, the proper field of the charlatan, and one on which it was scarcely prudent for a man with a reputation to lose to enter.' And when at the turn of the century the great astronomer, Simon Newcomb, settled the matter for most people with his published conclusion that 'the construction of an aerial vehicle which could carry even a single man from place to place at pleasure requires the discovery of some new metal or some new force.'

(2)

'For many years past,' Bell said in 1906, 'in fact from my boyhood, the subject of aerial flight has had a great fascination for me. Before the year 1896, I had made many thousands of still unpublished experiments having a bearing upon the subject; and I was therefore much interested in the researches of Professor Langley relating to aerodynamics. We were thrown closely together in Washington, and although we rarely conversed upon aerodynamics we knew that we had a subject of mutual interest and showed the greatest personal confidence in one another. I did not hesitate to show him my experiments, he did not hesitate to show me his. At least as early as 1894, Professor Langley visited me in my Nova Scotia home, and witnessed some of my experiments; and in May, 1896, he reciprocated by inviting me to accompany him to Quantico, Virginia, and witness a trial of his large-sized model. The sight of Langley's steam aerodrome circling in

the sky convinced me that the age of the flying machine was at hand. Encouraged and stimulated by this remarkable exhibition of success, I quietly continued my experiments in my Nova Scotia laboratory in the hope that I, too, might be able to contribute something of value to the world's knowledge of this important subject.'

When Bell began to experiment with his kite forms, stability was one of the greatest of the unsolved problems of flight. Kites were stable. He thought that 'a properly constructed flying machine should be capable of being flown as a kite, and conversely that a properly constructed kite should be capable of use as a flying machine.' It seemed to him that a kite that supported the equivalent in weight of a man and an engine in a twenty-mile breeze would support the actual man and engine when driven by its own power at twenty miles an hour — that it would make no difference whether the air moved against the kite or the kite against the air. Langley was confronted with the problem of keeping his structure light enough to be flown by the meagre power then available, and kites were light. As a matter of fact, Maxim's celebrated machine which showed that it had the power to fly, in 1892, was built like a kite.

Bell began by building small Hargrave box kites which flew well, then bigger ones that flew badly, and so progressed — characteristically, by trial and error and not by calculation — to a giant with cells or boxes each 'as big as a small room,' which nothing but a hurricane could fly.

It may have been this particular kite, but if it was

not it was another and later colossus, that Bell waited for months to try out. There wasn't enough wind. Then, on a night before a holiday — Thanksgiving or Christmas — a gale came shrieking up from the southeast, sweeping the Bras d'Or into mountainous seas, tearing sloops from their harbour moorings, piling the Baddeck shores high with the rowboats which the laboratory staff had left riding placidly at their painters the night before. All night Bell watched the falling barometer and went to bed at his accustomed three o'clock with the gale howling its lovely promise in his ears. He was up and at the laboratory while it still blew its full force, waiting for the Baddeck workmen who were to start the kite skyward. The men, meanwhile, contemplating their earned holiday, looked at the raging bay and were well pleased that they need not row a mile and a half that day. To Bell, who never spared himself or any one else, and who never forgave neglect of his work, their non-appearance was wanton, unpardonable. Here was the gale for which he had waited, here was the giant kite quivering in its shelter, and because of a trivial, ridiculous holiday, these clods of men had failed him.

He might have sent for the men, who would willingly have come, walking the nine miles around by land if they had to, but that wasn't Bell's way. Furiously, he locked the laboratory door and went home to bed. When the men returned to work the next day, they found a posted notice informing them that the laboratory was permanently closed.

But Bell relented afterward, and the men came back.

(3)

The impossibility of flying the giant Hargrave was Bell's first encounter with the old law of similitude with which Simon Newcomb was to buttress his assertion concerning the impossibility of flight without the discovery of a new metal or a new force. It was the law of cubes and squares, by which — to put it very simply — a structure built twice as big as its model was eight times as heavy. The supporting surfaces increased as the square, but the weight went up as the cube.

It was from this premise that Newcomb drew his conclusion that, as soon as a structure was made big enough, it would be too heavy to fly. Professor Newcomb was a guest at Beinn Bhreagh soon after this, and it must have been a melancholy satisfaction to him to survey, in the big, earthbound Hargrave, this inexorable working of the law of cubes and squares.

(4)

A young newspaper man, Mark Sullivan, then in his twenties, went up to Baddeck for the Boston *Transcript* in September, 1901, to interview Professor Bell. His account gives a delightful picture of Bell in those years.

As I hitched my horse in front of the laboratory [he said], I saw three elderly men, busy with apparatus, just within the door. Quite the most striking in the little group — quite the most striking he would be, indeed, in any group — was tall and erect, with a suggestion of bigness in each dimension. By the flaring white beard and by the bushy abundance of perfectly white hair under a tam-o'-shanter lounging cap, I guessed he should be about

sixty-five. As my 'Who's Who' had given me the age of Professor Bell as fifty-four, I concluded this must be one of the scientific guests who come and go. Moreover, Mr. Bell, I knew, is of Scotch birth, and the big, dark eyes of the gentleman at the door were far more Italian than Scotch. Italian, too, was the olive skin, the highly animated features, and the gestures, ample and frequent.

But when I asked where I should find Mr. Bell, he proved to be the inventor himself. His manner of speech I quickly learned was likewise of Italian speed, and his cordiality was that of the most kindly nation in the world, whichever it may be. Before I could make him understand that I had an errand, while he yet took me for a passing tourist coming out of idle curiosity to see him and his laboratory, he had suggested a dozen plans for my entertainment — would I look through the laboratory, would I drive over the grounds, would I take the view of the lakes from the other side of the mountain, would I come to his home in the evening?

Ah, how many hearts Bell won, and how many visitors he got rid of, by that cordial suggestion that they should walk through the laboratory or go and look at the view!

Finally, when I made it known that I had come to interview him about his experiments with flying machines, the habitual merriment in his eyes took on an added twinkle that seemed to herald some sort of practical joke. 'Ah, it is not I — it is my guests you should interview. Allow me to introduce you — but I forgot. My guests are very distinguished, they are incognito to newspaper men — Mr. Jones, Mr. Newspaper Man; Mr. Newspaper Man, Mr. Smith.' But thanks to the illustrated weeklies and a fairly general knowledge of celebrities, I had recognized in the alert, active Mr. Smith, Professor Langley, of the Smithsonian Institution; and in the keen-eyed, grey-bearded Mr. Jones, the distinguished astronomer, Professor Simon Newcomb.

Later that day, Sullivan took his way across the Bay to the Bell house. He goes on:

There is everything in the point of view. Angus MacAngus, the Gaelic boatman, who rowed me across to the Point of Beinn Bhreagh that evening, asked me, with the friendly interest of every one who serves you in this simple community, whether I was going to see Mr. Bell.

'He's the queerest mon you ever see in all your life, that Mr. Bell,' said my Scotch Charon, with the half-pitying, tolerant tone in which one discusses a well-intentioned but eccentric acquaintance, and in a broad Scotch brogue that made me grateful for the darkness that hid my smiles. 'He goes up there on the side of a hill of a sunny afternoon with a lot quaer thing-a-ma-jigs and there he fools away the whole livelong day, mind you! Now, what do you think of that? And him with that much money he might spend every day of his life on a yacht enjoying himself. He sets up a blackboard on the hill there — you can see it most any day — and he marks down figures about these kites and the quaer machines that he keeps bobbin' around in the wind. And God knows the kites are poor things. I could make better kites myself. He must have fifty of them in all kinds of quaer shapes. And these men that come to visit him — they goes up there with him, and there they do be spending the livelong day flying these kites — old men, mind ye, that you'd think would have some business of their own to attend to. It's the greatest nonsense I ever see in all my life.'

Bell declined to be interviewed on his experiments, but confidently predicted the ultimate perfection of the flying machine, and just as confidently predicted that the 'balloon feature will disappear entirely,' which only proves that he wasn't right all of the time.

(5)

That winter of 1901, Bell invented his tetrahedral cell which was to solve the problem of his man-carrying kites and outwit the law of cubes and squares.

He had flown several small kites on one rope where a single kite could not be flown, and it had occurred to him that instead of flying a team of kites he could fasten a number of them together to form one large structure. Then the weight and the wing surface alike would simply be the sum of the separate kites.

But the Hargrave box cell would not do. Two of them flew well, but a number tied together did not. Besides, the box cell was structurally weak and required a great deal of bracing, and bracing added to the weight and head resistance. Plainly a new form of cell was needed. Circular cells, polygonal cells, cells of six and eight and twelve sides were made and tried and discarded. Some of them looked like enormous cart wheels — doubtless the forms which excited the compassion and pity of 'Angus MacAngus.' The triangular cell was evolved next, braced in two directions, but even it was structurally weak; and then Bell devised a cell which could be made self-bracing in every direction by making it triangular in every direction — or tetrahedral in form.

Nothing could be more typical of Bell's genius — or more confusing to experts — than this simple production of a perfect engineering form, combining extreme lightness with great strength, and with only the most rudimentary knowledge of engineering science to bring it into being. Bell was accustomed to demonstrate this tetrahedral construction by

taking six matches, placing three of them on a table to make an equilateral triangle, and standing the other three up over it like the three legs of a tripod. It was the old parlour trick of making four triangles out of six matches.

The first of these cells were made of spruce sticks not much stouter than matchwood; the later ones of hollow aluminum tubing of several diameters, extremely strong and light. In the kite structures any two sides of the tetrahedron were covered with fabric, for lifting surfaces, to form a winged cell, as strong as a solid and only a fraction as heavy.

'It is not simply braced in two directions in space like a triangle,' Bell said, 'but in three directions like a solid. If I may coin a word, it possesses "*three-dimensional*" strength; not "two-dimensional" strength like a triangle, or "one-dimensional" strength like a rod. It is the skeleton of a solid. . . .'

Multiplied to any number they formed a structure which was no heavier than the sum of the individual cells, they confounded the law of cubes and squares, and they flew like a flock of birds. The little ones darted up into the air 'with a shrill whistle,' climbing to extraordinary heights; the big ones, six feet on a side and flown on manila ropes, were towed by one of the workmen; and the giants, twelve and fifteen feet over all, were sent skyward by tying the rope to the collar of one of the farm horses, and then having the steed galloped down the hill.

Voluminous notes were made, every observation was initialled and dated, every flight was photographed and the date scratched on the film. In later work, Bell's insistence on an unimpeachable record

resulted in the use of a four-foot plank with the date in large white letters. This was photographed with the picture. There was a laboratory tradition that the only employee ever dismissed had been dropped for faking one of these dates.

Bell's experience in the telephone litigation hung, ominous, over every experiment.

He counted that day lost in which something was not signed, dated, and photographed. The first fabric used for the kites was a light-weight cotton, but it photographed poorly and was replaced by an extremely light, tough silk of a brilliant red that made the kites look like showy-plumaged birds soaring against the blue sky.

From early May to late November, MacNeil and Ferguson built one model after another, and everybody went out on the hillside to see them flown. A little observation house in the form of a planked-in tetrahedron, with an open side, provided a shelter from the wind for Melville Bell — now over eighty years of age — who reclined under a rug, watching his son's burly figure in homespun knickerbockers, and Norfolk jacket blown wide, hearing his resonant shout contending with the gale.

It was all very exciting, and picturesque, and utterly unscientific. All Bell wanted was the result. If he knew that the upward pull on the kite represented its efficiency, and its backward pull, horse-power, there is nothing to indicate it in his published record. Pulls were now and then given in terms of weights lifted, but usually they were recorded as being strong enough, or not strong enough, to snap a piece of manila rope; to wrench out cleats 'such as are used

to fasten men-of-war,' or to pull Neil MacDermid thirty or forty feet up into the air. Wind velocity was determined by the presence and number of whitecaps on the bay — a breeze that raised white-caps was a ten-mile breeze.

Years before, Bell had made exhaustive propeller tests with a whirling table, perhaps inspired by Langley's Allegheny work of the eighties. Hundreds of intricate models were made and months of time spent in watching their behaviour. But because they were not accurately measured, the observations had not the slightest scientific value.

It was not Bell's habit to accept other people's conclusions, or to do things other people's way. He wanted to work everything out for himself. It was the trait that made him great and, equally, it gave him his blind side. Without it he would not have wasted years of time and effort, and without it he would never have invented the telephone.

(6)

Graham Bell had been elected a Regent of the Smithsonian Institution in 1898. S. P. Langley had come to the Smithsonian as its Secretary ten years before.

Bell's belief in the value of Langley's experiments with steam-driven flying-machine models had much to do with the appointment, in that year, of a Board by the War Department to investigate these experiments with a view to determining the possibility of developing a large-sized machine for military purposes.

The outcome of the Board's favourable report was

an allotment of fifty thousand dollars to this end. Langley agreed to give, without compensation, the time that he could spare from his duties as Secretary of the Smithsonian.

No project ever started with fairer prospects of success than this venture of the United States War Department in charge of a great scientist who was an authority on aerodynamics.

A contract was signed with an engine-builder, guaranteeing delivery of the required light engine in February, 1899. Langley's earlier models had been launched from a houseboat in the Potomac, an arrangement that gave the advantages of landing on a fluid medium rather than on the unyielding land, and work was now begun on a larger houseboat which provided workshop space and room on top for the turntable and the launching gear that literally shot the machine into the air. The first of a series of unforeseen delays came when the engine-builder failed to deliver the engine. They tried, vainly, to get another American builder to take the contract, and at last, in the spring of 1900, Langley took his engineer and assistant, Charles M. Manly, to Europe to get one, if they could, from some manufacturer of automobiles. But even in France no one was prepared to build an engine weighing only ten pounds to the horse-power, and in August, Langley came back to Washington to build it himself in the Smithsonian shops.

'Only in the spring of 1903, after two unforeseen years of assiduous labour,' Langley said afterward, 'were these new engines and appurtenances ready.' His large machine (the Langley aerodrome, now in

the Smithsonian) and a quarter-size model of it were towed down the Potomac on the houseboat that summer, to a point directly opposite Widewater, Virginia, forty miles below Washington, where the river is three miles across.

One recalls that the fifty thousand dollars had to pay for everything, and that expenses had begun in 1899. Langley received nothing for his time. Ultimately, it was said, he put upwards of twenty thousand dollars of his own money into the work.

Fogs hung over the river, metal parts and fittings rusted, one delay of repair and adjustment followed another, but at last the quarter-size model was launched and flown successfully on the 8th of August. It weighed only fifty-eight pounds, but it was in every way the counterpart of the big machine.

There was, somewhere or other, the most deplorable mismanagement in this whole Langley episode. Entirely apart from Langley's distaste for publicity, especially premature publicity, he was bound by his agreement with the War Department to maintain the strictest secrecy in his tests. Yet, whatever the reason for the attitude, the experiments were treated as Langley's experiments aided by the War Department, rather than War Department experiments directed by Langley. And, considering the current point of view on flying, it was not unnatural that the press should consider the event a performance of Darius Green and his flying machine in person, and should despatch correspondents to Widewater to get the story.

No one can read the documents, Langley's own

report to the Smithsonian, the evidence of official observers, and the newspaper accounts, without feeling that the War Department was very half-hearted about the whole affair. No test of ordnance — Langley's appropriation came under 'engines of war' — in which secrecy was an important element, should have been left open to the shameful jeers of newspapers.

The Langley houseboat was moored near a small island in the Potomac where the staff had their quarters. The correspondents had to make their approach by small boats, rowing a mile and a half, only to be denied access by the military guard and refused all information. The region was malarial. That summer there was much rain and oppressive heat. The newspaper men could not even find out how long the tests were to last, and day after day as the hot weeks passed they cruised impotently around the houseboat, which they nicknamed the 'Buzzard,' and then went back to the Virginia shore, fought off the mosquitoes, took quinine and whiskey, and waited. It was expensive for their papers and exasperating for them.

The successful test of the steam-driven model, on August 8, was announced in the papers as a dismal failure, and Manly's counter-statement of its success was openly laughed at. It was plain at this point that the tests had not the remotest chance of a fair hearing.

Aboard the houseboat one distressing delay followed another. The wings of the large machine were found to have become affected by the dampness, and while repairs were being made, a violent storm swept

up the river, dragged the craft from her moorings, scattering its attendant launches, boats, and rafts far and wide. Propellers that turned over satisfactorily in the shop snapped unaccountably under the strain in the open. The full-sized aerodrome had to be taken apart and carried up, piece by piece, to the launching-ways on the roof, to be reassembled, consuming some four or five hours, and frequently when this operation had been begun under favourable conditions the elapsed four or five hours brought a change in the weather and the trial had to be abandoned.

This succession of accidents and delays lasted until October, when the first of the trials was made. A forward guy post caught in the launching-ways at the moment of release and the whole machine — carrying Manly as aviator — was precipitated into the water. A shout of laughter went up from many newspapers, and even the more tolerant called the test a fiasco.

Manly was uninjured and the aerodrome only slightly damaged, but before repairs could be made, another gale swept the Potomac, carrying away all the auxiliary craft as before, this time demolishing many of them. When the houseboat was finally removed to Washington, these launches and rafts had to be replaced at an expense that made an alarming hole in Langley's dwindling appropriation.

Langley's funds were now so low that it was plain that he would be unable to carry the experiments over to another season, and he determined on a last desperate throw, hoping, despite the lateness of the season, unpropitious weather and an unfavourable

site for the experiment, that this time they would get the aerodrome safely into the air.

For unrelieved tragedy the scene has no like in American invention. It was November, and five hours of the short day were consumed in assembling the machine. In the approaching darkness, with a strong tide running and a rising wind, Manly got into his life-jacket, the engine was started, and the launching-car ran smoothly down the short track. And again, at the moment when it should have been shot into free flight, the machine stuck in some unaccountable way, and fell into the water.

Like Greek tragedy, with the hundreds of unsympathetic watchers on the shores for chorus, the event seemed to move inexorably to a hopeless, predestined curtain. As soon as Manly had been pulled out of the water, Langley — more concerned for his assistant's safety than for the machine — followed him into the houseboat to make sure that he was uninjured, and in his absence an overzealous tugboat crew grappled for the partly submerged aerodrome, and in their clumsy handling broke it to pieces. 'It was almost heart-breaking,' Manly said afterward, 'to look at the wreck that they made of it.'

The newspapers said that it broke in two in the air and could not fly.

Langley's work had to be abandoned, within reach of the success it should have had, because his funds gave out, but his real defeat was at the hands of the newspapers. In the face of widespread public censure, the War Department declined to add to its appropriation. And, in 1903, there was no person or institution in the United States that would give a

dollar to aviation. Bell said, in 1906: 'The ridicule of the newspapers effectually prevented Professor Langley from securing further financial aid; and, indeed, broke his heart. There can be little doubt that the unjust treatment to which he was exposed contributed materially to the production of the illness that caused his death.'

Even the New York *Times*, which had treated the experiments with scepticism but without animus, said editorially on December 10, 'It would serve no useful purpose to say anything that would increase the disappointment and mortification of Professor Langley,' and, after several paragraphs of not unfriendly criticism, concluded:

> We hope that Professor Langley will not put his substantial greatness as a scientist in further peril by continuing to waste his time, and the money involved, in further airship experiments. Life is short, and he is capable of services to humanity incomparably greater than can be expected to result from trying to fly. Men like Santos Dumont should have this field all to themselves.
>
> For students and investigators of the Langley type there are more useful employments, with fewer disappointments and mortifications than have been the portion of aerial navigators since the days of Icarus.

But Langley was not without his defenders. Here and there readers wrote in protest to the papers, asking fair play, and the American correspondent for the *Illustrirte Aeronautische Nachrichten*, signing himself 'C. D.,' wrote to the *Times* in vigorous rebuttal of its editorial and took the occasion to point out that a balloon was not a heavier-than-air flying machine. No one spoke out in his defence and on the certainty of heavier-than-air flight in assertion more

positive than Bell's. If he was putting his reputation in peril, at least his money was his own. Interviewed in Halifax in August, he was reported as asserting that 'the invention of a successful flying machine was a possibility for the near future' and that he expected to have one in successful operation himself before the end of that summer. The cautious phrasing of the despatch reflects amusingly the point of view of the decade. Doubtless a considerate reporter, liking and feeling a little sorry for the old gentleman, modified Bell's certainty to 'a possibility for the near future.'

(7)

It is impossible to view the parallel work of Langley and Bell, twenty years on, without a regret that the freedom and wealth that were Bell's to expend on his kites, which served no practical end in themselves, were not also Langley's for his unlaunched aerodrome. Langley realized only too well the errors in his method of releasing the machine into the air, the inefficiency in taking the machine apart and reassembling it at each trial, and the total unsuitability of his houseboat for both housing and launching; but he had had to learn all this for himself and he had no money to profit by the costly experience. Years later, his aerodrome was successfully flown, as a land machine, without a single change in design or engine.

But neither his influence nor his experience was lost.

The Wright brothers, who made their first flight at Kitty Hawk a few weeks later, were to acknow-

ledge their indebtedness to Langley. 'The knowledge,' they said, 'that the head of the most prominent scientific institution of America believed in the possibility of human flight was one of the influences that led us to undertake the preliminary investigations that preceded our active work. He recommended to us the books that enabled us to form sane ideas at the outset. It was a helping hand at a critical time, and we shall always be grateful.'

And, guided by Langley's negative experience, Bell was to concentrate on a means of getting a flying machine off the water, and alighting on it again, which had its ultimate development in the American seaplane.

In 1906, the Aero Club of America adopted resolutions in recognition and appreciation of Langley's work. A copy reached him on his deathbed. When asked what he wished done with the communication, he said, 'Publish it.'

'To all who knew his extreme aversion to publicity in any form,' Bell said, 'this reply indicates how keenly he felt the misrepresentation of the press.'

CHAPTER XXIII

(1)

In 1906, Bell went back to Scotland to receive an honorary LL.D. from Edinburgh University.

Melville Bell, eighty-six years old, had died in Washington the summer before. Eliza Grace Symonds had predeceased him, and, close to his eightieth year, he had married for the second time. Long before his parents' death, Bell had begun to collect information about his forbears, and with this visit to Scotland he began a determined search for his Bell ancestors.

In Edinburgh he looked up collateral relatives, and with his genealogical correspondent, the Reverend Walter Macleod, searched parish records for Bell births, marriages, and deaths. He searched old city directories, and spent long April afternoons copying tombstone inscriptions in Fifeshire burying grounds —filial epitaphs in memory of parents deceased at four-score, brief elegies for Margery who died aged twenty months, and for sons who grew up to die in Melbourne or Bombay. One of these last, in memory of Melville Richard, master of the ship *Jane of Glasgow*, who died at Black River, Jamaica, in 1817, was the cousin for whom Bell's father was named.

He took Mabel Bell to see the cottage at Trinity.

'Mr. and Mrs. Ross drove with us to Trinity,' she wrote, 'to find Milton Cottage, where Alec's family used to spend the week-ends. I presumed it was some distance out, in the open country, but it is just

in the suburbs now among the villa residences. The drive is principally between high stone walls, and at one of the highest of these we stopped. Alec and Mr. Ross had a dispute as to whether a peculiar square tower which was about all one could see over the wall belonged to his time or not. Mr. Ross maintaining it did, Alec disputing this.'

But the new owner had bought the next property, thrown both together, and enlarged the cottage, so that 'Alec did not recognize it at all.'

(2)

The Beinn Bhreagh kites grew. The old laboratory became a machine shop, and new buildings spread out. More workmen rowed across the bay. Tetrahedral frames were made by the thousand and seamstresses stitched on them the yards of scarlet silk that made them into winged cells.

A photographer photographed all day long.

Bell began to refer to his tetrahedral structures as aerodromes. He espoused Langley's use of 'aerodrome' as opposed to 'aeroplane' on the technical ground that 'aeroplane' was a supporting surface and not the whole machine. He consulted Greek lexicons, corresponded with philologists and with editors of dictionaries, and enlisted editors of flying periodicals in the fight. But it was a lost cause. 'Aerodrome' became accepted usage for a flying-field. Bell never gave in, but future generations reading his statement about an aerodrome circling in the sky will think it an hallucination.

Bell's most skilful workman, Hector P. MacNeil, who had devised the first means of fastening the

tetrahedral cells together, now invented a method for making the cells by machinery with stamped metal corners to hold the rods, and, in 1907, the giant Cygnet was ready to carry a man.

The Cygnet, forty-two and a half feet from tip to tip, was stable and light and strong. Bell didn't expect it to fly very fast. Speed was no part of his plan. But it would be safe. All that was needed now was an engine to get it up off the water from its pontoon floats.

Bell had heard of a young American, Glenn H. Curtiss, who was building motor-cycles at Hammondsport, New York, and he got Curtiss to come up to Cape Breton to advise him on motive power.

(3)

J. A. D. McCurdy, son of Bell's early secretary and assistant, had brought a school friend to Beinn Bhreagh the summer before. McCurdy was in his junior year at the School of Science of Toronto University, and his friend, F. W. (Casey) Baldwin, had just graduated in mechanical engineering in the class of '06.

Baldwin, who came of one of the most distinguished families in Canada, was a grandson of the Honourable Robert Baldwin, famous Premier of Upper Canada and one of the founders of the Dominion. The younger Baldwin was then enjoying minor but pleasant fame, on his own account, as perhaps the best all-around athlete Canada had ever produced. His nickname has its own implications, and, so far as his native Toronto is concerned, none of his later and more lasting achievements have ef-

faced the particular memory of his football and his prodigies as centre-half. Doubtless it was this renown that saved Baldwin's reputation from blot when it became known that, having read Langley's book, he believed enthusiastically in mechanical flight. But when the rumour spread that he proposed to write his thesis on aerodynamics, Baldwin was summoned before the Dean, and it was suggested, not unkindly but firmly, that some more stable subject would be more acceptable to the faculty.

Out of this brief meeting, when Bell was nearly sixty and Baldwin in his early twenties, grew the closest and happiest association of Bell's life.

Baldwin went to the summer school at Cornell that year, but, at Bell's request, came back to Cape Breton in the autumn to build a tower on the top of Beinn Bhreagh, to demonstrate that the tetrahedral principle could be applied to ordinary engineering structures and could stand in the teeth of all the winds that blew across the Bras d'Or. It is worthy of note that the tower, put up as a temporary structure, and built of ordinary half-inch iron pipe, withstood the storms of that hilltop for more than a dozen years, and was only taken down at last because it had long ago served its purpose, and nothing had been spent on it for repairs.

(4)

Curtiss and Baldwin and McCurdy were all at Beinn Bhreagh in the summer of 1907. At the same time, Lieutenant Thomas E. Selfridge, of the United States Army—like Baldwin, an enthusiast

on flight — sought permission to observe the Cygnet experiments as a representative of the United States Government, and joined the group at the Bell laboratories.

'There we were,' Graham Bell said afterward, 'living in my house, myself an elderly man surrounded by brilliant young men, each an expert in his own line.' It was his happiest rôle, a master surrounded by his pupils.

Bell was still insisting that there could be no doubt about the rumoured flights of the Wright brothers. He had been in England that May to receive Oxford's degree of Doctor of Science, and, to the reporters who interviewed him in London, he talked on flying instead of on the telephone. In June, the New York *Times* ran a small paragraph, with the lead 'Airships Assured, Says Inventor of the Telephone,' in which it quoted Bell:

> I have not seen the Wright brothers' machine, but I dined with Mr. Octave Chanute, of Chicago, author of 'Progress,' and the late Professor Langley, a few days after Mr. Chanute had actually seen the performance of the Wright brothers, and I am satisfied that the machine can do all that is claimed for it.

Selfridge had brought meteorological equipment to Beinn Bhreagh, to measure wind velocities and altitude; spring balances and levels were introduced by young engineers determined to have accurate readings of pulls; and in between engine and propeller tests, which occupied Curtiss and Baldwin and McCurdy that summer, they all went out on the Bay when the breeze was stiff, towing kite models with a motor boat. The craft shipped water steadily and

they were always drenched. And, having instructions from Mrs. Bell not to let Mr. Bell get his feet wet, they did their best to keep him dry; but he never paid any attention to them, one of them said afterward, and habitually stood, gazing up at the kite, with his unbuckled overshoes full of water up to the top.

CHAPTER XXIV

(1)

It was Mrs. Bell who suggested the Aerial Experiment Association. They had come home one September afternoon, to dry themselves out before the big fireplace in the wide hall and devour buttered toast while Mrs. Bell poured tea. Undoubtedly she had thought it all out in advance. It is more than likely that Mabel Bell wondered whether those kites were ever going to make a flying machine, for, besides her talents and charm, she had a very keen mind. Anyway, she knew that it was profoundly stimulating to her husband to have all these enthusiastic young men about him, and now she suggested that they form themselves into such an association as the Volta Laboratory Association had been. She had just sold a corner lot that had been going up in value and she offered to start them off with twenty thousand dollars.

So the 'A.E.A.' came into existence in October, 1907.

They all went down to Halifax, a day's journey by train, to draw up their agreement; not because they couldn't have done it at Baddeck, but because Bell liked doing things ceremoniously. He got the notary's signature authenticated by the American Consul-General, just by way of a little extra flourish.

The agreement opened:

Whereas, the undersigned Alexander Graham Bell, of Washington, D.C., U.S.A., has for many years past been

carrying on experiments relating to aerial locomotion at his summer laboratory at Beinn Bhreagh, near Baddeck, N.S., Canada, and has reached the stage where he believes that a practical aerodrome can be built on the tetrahedral principle driven by an engine and carrying a man, and has felt the advisability of securing expert assistance in pursuing the experiments to their logical conclusion, and has called to his aid Mr. G. H. Curtiss, of Hammondsport, New York, an expert in motor construction, Mr. F. W. Baldwin, and Mr. J. A. D. McCurdy, of Toronto, Engineers, and Lieutenant T. Selfridge, 5th Field Artillery, U.S.A., military expert in aerodromics, and

WHEREAS, the above-named gentlemen have all of them given considerable attention to the subject of aerial locomotion, and have independent ideas of their own which they desire to develop experimentally, and

WHEREAS, it has been thought advisable that the undersigned should work together as an association in which all have equal interest, the above-named gentlemen giving the benefit of their assistance in carrying out the ideas of the said Alexander Graham Bell, the said Alexander Graham Bell giving his assistance to these gentlemen in carrying out their own independent ideas relating to aerial locomotion, and all working together individually and conjointly in pursuance of their common aim 'to get into the air' by the construction of a practical aerodrome driven by its own motive power and carrying a man . . .

As in the Volta Laboratory Association, all patents and profits from them were to be the joint property of the associates. The Association was to continue for one year. 'To get into the air,' was Selfridge's phrase. Bell was chairman, without remuneration. Curtiss, the senior of the younger group and already established as a manufacturer, was to be director of experiments 'in special charge of motive power' and was to receive five thousand

dollars a year while he gave his full time to the Association. Baldwin as chief engineer, and McCurdy as assistant engineer and treasurer, received a thousand dollars a year each. Selfridge declined to accept any salary, since he was a detailed observer on full pay from the United States Army.

(2)

They started off with the newly completed Cygnet.

In December, the local steamship company lent their steamer, *Blue Hill*, and the Cygnet was taken out in the Bay for a towing test.

It was a cold day with a threatening sky, and Selfridge, lightly clad under a suit of oilskins, with long woollen stockings and no boots, took his meteorological equipment and crawled into the manhole. He lay face down, covered up with rugs to keep warm.

The *Blue Hill* got up speed. The kite lifted from her tender, rose, and soared one hundred and sixty-eight feet above the water. If she wasn't flying, at least she was aloft, and she was carrying a man. But for some reason — perhaps because the steamer blanketed the wind — the kite began to descend after seven minutes in the air. As she came down — so evenly and gently that Selfridge didn't know he was dropping — a gust of wind blew the steamer's smoke across her stern, obscuring the view of the Cygnet, and before the rope could be cut, the kite had been dragged through the water at the *Blue Hill's* best speed. Selfridge dived clear, and escaped with only a ducking, but the kite was wrecked.

This mishap ended any near prospect of putting an engine in the Cygnet, and concluded the Beinn Bhreagh experiments for the season. The associates went down to Hammondsport for the winter.

(3)

The work of that winter and the ensuing spring has given the A.E.A. an important place in the chronicle of American aviation, yet, guide and friend though he was, Bell had very little to do with it. He safeguarded the Association's patents by insisting on full and regular notes of experiments, paid occasional visits to Hammondsport, kept in constant touch with the associates from Washington by mail and wire, and had an elaborate *Bulletin* issued at his own expense to preserve a record of the work; but the four useful flying machines which the A.E.A. built were the work of the four younger men. Bell's single important conception — that of rising from the water — is the one thing usually credited to the Association which was his own.

(4)

Glenn H. Curtiss was then building at Hammondsport the best light engine in the country, and the town on the shores of Lake Keuka was a pilgrimage for all sorts of people who wanted to get into the air. When the A.E.A. arrived, in December, 1908, man's longing to fly was already represented at Hammondsport by a wing-flapping machine, a helicopter, assorted balloons, and their assorted owners. In their leisure hours that year, McCurdy, Selfridge, and Baldwin gave a hand to a nice old gentleman

who had a helicopter, obligingly holding the bucking contraption down to the floor of its shed while its owner studied the strivings of its engine to take it off in all directions.

Graham Bell went on to Washington, and left his young associates to get into the air by themselves, if they could.

They had Chanute's handbook, and Baldwin as chief engineer. All the work was done jointly, but each associate was to have a machine named for him, and in theory he was to be mainly responsible for his own design. But, as it worked out, Baldwin had most of the structural ideas, and, although he modestly claims that this was only 'because I did the drawings,' so many important and now fundamental features were his that the other associates insisted at last that he have at least one patent in his own name.

Baldwin has always given Octave Chanute the fullest credit for the groundwork on which the A.E.A. built. In his own enthusiastic phrase, 'Any schoolboy could build a flying machine from Chanute's handbook.' Chanute had helped and started the Wrights, and now the A.E.A began, as Orville and Wilbur Wright began, with a glider built on Chanute's calculations; and then went on to their first machine. In courtesy to the Government, this was to be Selfridge's.

They used for the wing covering some of the lightweight, tough red silk which had been left over from the Cygnet, and they called her the Red Wing. Her official designation was 'Drome No. 1, Selfridge's Red Wing.'

The Red Wing's main supporting surfaces were curved horizontally (instead of being straight as in the Wright machine) and tapered in plan view like a bird's wing. It is substantially the form of most modern machines. Very little was then known about control, but the associates thought they had provided all the automatic stability necessary in making flexible certain parts of the upper surfaces. Instead of perching the pilot's seat up on an open wing, as every one else did, they made a stream-line enclosure for it. To start the machine on the ice of Lake Keuka, they provided her with sledge runners.

High winds delayed the first trial for weeks, and, when the weather cleared, Selfridge was absent on business and Baldwin was chosen to make the flight. It was the 12th of March, 1908. They ran her out on the ice, her forty-three-foot span of scarlet wings brilliant in the sun against the expanse of snow and the blue winter sky, and, while Baldwin climbed into the little cockpit — the first aeroplane cockpit — Curtiss went over the engine for the last time. Every one stood clear. One of the men spun the propeller, and she was off — gliding away down Lake Keuka close to twenty miles an hour! 'Gee,' they said, 'isn't she pretty!' At the end of a hundred and fifty feet Baldwin pulled back on the lever, she rose, climbed ten feet, and flew!

It was the first public flight of a heavier-than-air machine in America.

What a pity that the Dean of Baldwin's old school wasn't there to see!

Associates, staff, spectators, everybody, rushed after her. Three hundred-odd feet further along, she

came down. Everybody cheered. The machine had turned herself around, and Baldwin started back on a return hop, only to land, at the wild gesticulations of his companions, who could see that one of the struts had given way as she bumped. And then, very carefully, the distance was measured — three hundred and eighteen feet, eleven inches!

No one has ever been able to shake Baldwin's calm acceptance of the performance. What did he feel? Well, nothing in particular. Wasn't it very wonderful and thrilling? Well, no, he couldn't say that it was. They knew she'd fly.

The Red Wing was not too stable. She tilted sideways in a manner disconcerting even to the resourceful and agile young man at the controls. And in their eagerness about getting up, the associates had paid no attention to such a detail as getting down. As a thing of minor importance, the engine switch had been put in an inaccessible place under the seat. With both hands occupied with elevator and rudder controls, the pilot couldn't let go of anything to reach down and back under the seat for the switch, so that there was no way of stopping the engine before she landed.

On the 17th, Saint Patrick's Day, wearing a green necktie for his Irish blood, Baldwin took the Red Wing up again. Again she rose, straightened out, and flew. But the good Saint was not with him. The machine slid off the wind and came down on one wing. It was their first smash.

'Dear Casey,' Graham Bell wrote, on receiving the news of what he termed 'the Red Wing Disaster,' 'I am much relieved to know that you escaped from

the wreck of the Red Wing uninjured. Of course I am glad that the engine escaped, too, but I don't wish to put you both in the same sentence.' The engine was fully as important as the aviator in 1908.

At the second annual banquet of the Aero Club of America in New York that week, the flight of the Red Wing was acclaimed. Graham Bell had accepted the invitation with the proviso that he should not be asked to speak, but, after the president had lauded the Red Wing's performance, the members cheered Bell onto his feet. 'I really had nothing to do with the success of the experiment,' he said; 'the credit for its success was due to Mr. G. H. Curtiss, of Hammondsport, Mr. F. W. Baldwin and Mr. J. A. D. McCurdy, of Toronto. Mr. Curtiss, who may be called the motor expert of America, produced an engine developing forty horse-power weighing but one hundred and forty-five pounds. . . . In this company of experimenters,' he added, 'I must include Lieutenant Selfridge, of the United States Army, and Mrs. Bell, who supplied the capital for the scientific experiments to get the machine into the air. Although I do say it myself, I think this is the first time in America that a woman has taken an active part in making an experiment in aeronautics a complete success.'

(5)

The second A.E.A. machine was got under way at once.

They had used up all the red silk on hand, and, as it was expensive, they made the new wings of white

sail cotton. She was christened 'Drome No. 2, Baldwin's White Wing.'

Baldwin's crash in the Red Wing had shown him that agile shifting of the pilot's weight wasn't enough to keep the machine stable. In the new design, therefore, he incorporated hinged tips or ailerons to the extremities of the wings, so connected by wires to the operator's seat that they could be tilted up or down to produce a lateral righting effect when the machine tilted to one side or the other. It was to be an automatic control. When the machine tipped in the air, the aviator would instinctively lean to the high side. By a contrivance embracing his body the ailerons on the depressed side would be turned up, the ailerons on the elevated side turned down, and the machine would right itself. It worked. It was a far more efficient method than the wing-warping of the Wright machines. These wing-tips or ailerons of Baldwin's design have been fundamental to all balancing control ever since and are used in all modern heavier-than-air machines.

The ice was gone from Lake Keuka by the time the White Wing was finished, about the middle of May, so she was supplied with motor-cycle wheels to start her off the ground. She was hauled out to the local race-track — where the young associates raced their motor-cycles on Sunday afternoons — and housed in a borrowed circus tent.

On the 18th of May, Baldwin got her up, 'rose quickly to a height of twenty feet,' as a contemporary newspaper described it, 'and sailed away. . . . There was great cheering from the large crowd assembled and the records were officially attested for the Aero Club.'

Bell had come on to Hammondsport to witness this flight, and one that Selfridge made the next day with equal success. 'They were,' Bell said, 'very inspiring.'

There was a ploughed field on one side of the race-track, and on the other an orchard with an outcrop of stout oak stakes, several feet high, both very discouraging prospects for a landing if the machine got out of hand in either direction. After these first short flights, Curtiss flew the White Wing a record 1017 feet in nineteen seconds, before McCurdy took her up for her last flight and came down, either on Scylla or Charybdis, in the second crash of the Association. He went about for some time on a crutch.

(6)

The most important immediate result of these A.E.A. flights was their influence on the American point of view on aviation.

General public credence in flight began in the United States with the three hundred and nineteen-foot hop of the Red Wing in March, 1908.

The Wrights had flown long before, at greater altitudes, over longer distances, but not publicly. And the secrecy with which they surrounded their work only heightened the public unbelief, which is hard to gauge accurately in a day when flight is a commonplace. (The Wright brothers said later that they used to wonder why Graham Bell believed in their flights, when scarcely any one else did.) By the end of May, the New York *Sun* ran a prominent Sunday feature article on the Association, entitled, 'Man Really About to Fly.'

(7)

Graham Bell and his wife went on to St. Catharine's, Ontario, for Casey Baldwin's wedding in June.

(8)

The third A.E.A. machine, 'Curtiss' Drome No. 3,' incorporated the lessons of the previous machines and some improvements in the Curtiss engine. But out on the race-track she seemed to have very little lift. Selfridge suggested that perhaps the air was leaking through the porous cotton, so they got a big pot of linseed oil and put it on to boil on the little stove in the tent. It boiled over, caught fire, and for a few minutes things looked as though this was to end the career of Drome No. 3. The peril past, they set to work with whitewash brushes, slapping on the boiled linseed oil, doping the wings of a flying machine for the first time in history. It was an enormous improvement. She flew, they thought, like a June bug, so she was named 'Curtiss' June Bug.' She developed the best flying qualities of any Association machine up to that point and the associates entered her for the *Scientific American's* trophy for a heavier-than-air flying machine flying the first measured kilometre under test conditions. When Glenn Curtiss flew her and won the trophy on the Fourth of July, 1908, he made the first measured official flight in the United States.

This competition brought the Wrights into public flying in America.

The results with the doped fabric had been so successful that the associates tried to improve upon it for the fourth machine, which was to be Mc-

Curdy's. The Goodyear Rubber Company had developed a non-porous balloon fabric, a silver-grey, silk-like material with a thin lining of rubber. This stuff was used for the wings, and suggested the name 'Silver Dart.'

McCurdy's Silver Dart was flown successfully at Hammondsport, but her most famous performances were made over the ice of Baddeck Bay, after she was shipped up to the Beinn Bhreagh laboratories. There, in the winter of 1909, McCurdy made repeated flights, sometimes doing nine miles at a stretch. McCurdy proved to be the most successful aviator of the group. He was one of the best fliers of his time, and later went on from these — the first flights in the British Empire — to more ambitious flying.

While he and Curtiss were still flying the Silver Dart in Hammondsport, that summer of 1908, Baldwin had rejoined Bell at Beinn Bhreagh to work on the problem of getting a machine off the water.

CHAPTER XXV

(1)

Much of Graham Bell's determination to solve the problem of getting a machine off the water was due to his anxiety to make flight safe. He was never entirely happy while his young associates were risking their necks, as they were even when only thirty or forty feet up over Mother Earth; and when McCurdy was flying over the ice at Baddeck, one of the local doctors was always retained to hover around the spot in case of accident, a melancholy reminder of his peril which does not seem to have worried that intrepid young person at all.

Ultimately, flying machines would be obliged to fly over the sea, and consequently have to be equipped to start and alight on water, but Bell's chief concern at the moment was with the relative safety of water for the inevitable crash.

The tetrahedral structures had long ago been fitted with pontoons, but the pontoon float, like the ordinary hydroplane boat, utilizes only the bottom or under surface of the hull as a plane. Yet, in water, as in air, the greater part of the lift of a plane — something like three quarters of it — is given by the partial vacuum created over its upper surface when it is in rapid motion. To take advantage of this, Bell and Baldwin began to work with submerged blades or hydrofoils, that behaved in water very much as the wing surfaces of an aeroplane did in air. The principle was an old one, although they did not

then know how much of their early work had been anticipated by Cooper-Hewitt in the United States and by Forlanini in Italy. But its application to flying machines was new. Besides their efficient behaviour in water, the hydrofoils would continue to behave as lifting surfaces in the air instead of impeding progress as pontoons did.

Meantime, in Hammondsport, Curtiss and McCurdy had put pontoons on the June Bug, renamed her the 'Loon,' and tried to get her up off Lake Keuka. But she refused to rise.

(2)

In September, Selfridge went down to Fort Myer, Virginia, to fly as an official observer with Orville Wright, and was killed in a crash of the Wright machine. He was the first victim of modern aviation. This tragedy, touching the Association so nearly, renewed and strengthened Bell's determination to develop his tetrahedral form of flying machine. It might not climb very high, and it might not fly very fast, but it would be stable, and safe.

(3)

That autumn the A.E.A came to the end of its year's existence and its money resources, and Mrs. Bell gave ten thousand dollars to continue its work for another six months. Headquarters was removed from Hammondsport to Beinn Bhreagh and the laboratories expanded to the dimensions of a small industry to build the fifth A.E.A machine on the tetrahedral principle. New sheds went up, building foremen and machinists were added to the

old staff which had built and flown the kites, and work was begun on Cygnet II, which was to be 'Drome No. 5, Bell's machine.'

On the last day of the year, 'Baldwin's new hydrodrome,' a hull equipped with sets of hydrofoils, was launched at Beinn Bhreagh. The interrogation mark, ?, painted on her stern, indicated the point of view on her performance. She was called the 'Query.'

The Cygnet II, Drome No. 5, never got into the air, and neither did a second machine, the 'Oionos' — named for the Greek Bird of Augury, like an old and favourite kite.

The Oionos was Bell's compromise with lifting surfaces, and was really a triplane with tetrahedral cells for struts. The Oionos might have flown if she had had more power, and in any event, Graham Bell's contribution to aviation did not depend on the theory or performance of his tetrahedral aerodromes.

He was at this time a self-appointed committee of one to advance aviation in America, and advance it he did.

In order to talk about flying, he went to public banquets when he would rather have stayed at home; he gave newspaper interviews to reporters who afterwards recalled his twenty-five-cent cigars, his cordiality and their respectful attention while the visionary old gentleman talked about flying the Atlantic. And his practical interest was not confined to the A.E.A. He paid for a photographic record of the historic flights of the Wrights — it was Bell who insisted that they were historic — pre-

sented it to the Smithsonian, and, as a Regent of the Smithsonian, urged that institution to establish a medal and bestow it on the Wrights.

'The Wright brothers are being deservedly honoured in Europe,' he wrote to Secretary Walcott in December, 1908. 'Cannot America do anything for them? Why should not the Smithsonian give a Langley Medal to encourage Aviation?'

Bell went on to Washington from Baddeck, a few days later, for the December meeting of the Board of Regents, and urged the resolution that established the Langley Medal; called on President Roosevelt in behalf of the Aero Club to ask the President to attend the Club's banquet in honour of the Wright brothers and to present its medal to them. And when distinguished citizens declined invitations to the banquet, the Aero Club wrote to beg Bell to use his influence to persuade these notables to reconsider.

He and Mabel Bell were aviation's earliest patrons in America.

That autumn, Henri Farman flew from Châlons to Reims, seventeen miles, in twenty minutes! The next day Louis Blériot flew from Toury to Artenay over fences and houses and back to the starting-point, at a little over fifty-three miles an hour; and in December, Wilbur Wright broke every record when he stayed up in the air for two hours and eighteen minutes. That month the President of the Aero Club, in a public address, lamented: 'The apathy of the American people in the science of aviation is deplorable. In France there are prizes to be gained amounting to as much as fifty thousand

dollars; here there is practically nothing tangible to incite genius in this line. . . .'

(4)

The A.E.A. expired by time limit in March, 1909. Its affairs were left in the hands of a trustee, who was, however, a banker and not a promoter, and so good a banker that he did not care to imperil his financial standing by any attempt to interest capital in flying. McCurdy and Baldwin made an attempt to start Canadian aviation in their 'Canadian Aerodrome Company,' and did their best to persuade their Government to finance further work, as the French Government had financed the Wrights. In two machines, Baddeck No. 1 and No. 2, they developed new structural features, including the first enclosed gas tanks, and the first wing radiators. Bell made public addresses in an effort to arouse interest in their work. An official observer was sent from Ottawa, and later, at the Bell invitation, the Governor-General — then Earl Grey — travelled down to Cape Breton and stood in a rain-soaked meadow while the young aviators coaxed the machine into flight. 'Extraordinary!' said His Excellency. 'Extraordinary! How like a bird!' But Parliament remained unpersuaded. When a later trial resulted in a crash, the little Aerodrome Company and Canada's opportunity were wrecked with the machine.

(5)

When the A.E.A. was dissolved in March, 1909, its *Bulletin* went out of existence with it. In July,

Bell began to issue its successor, the *Beinn Bhreagh Recorder*. It was a little typewritten bulletin, duplicated at first by means of gelatine pads and later by carbon copies, issued once a week or once a month, and designed to record the work of the laboratory and the estate. For a long time it included personal notes about the family and staff. When enough copies had appeared to make a volume of four or five hundred pages, these were bound and a new volume begun.

At first the expense of the photographs which illustrated it limited the number of copies to seven, but by the time four volumes had appeared the number was increased to fifteen. These were divided up as presentation copies to members of the family and friends, with loan copies to employees. The loan copies were distributed to lessen the danger of loss by fire, but were to be returned to Bell. 'This will give me five copies besides my own,' he wrote, 'which I can have bound and deposited in libraries or other places for permanent preservation.'

From its earlier scope the *Recorder* expanded to include old dictations, papers read before scientific societies, biographical material, and, as time went on, Bell began to take it with increasing seriousness and to lay more stress on its 'primary object . . . to secure a permanent record of the more important experiments and researches carried on by me.'

The number grew to twenty. By this time the little bulletin was being mimeographed and Bell considered the advisability of issuing fifty or a hundred copies. The more the *Recorder* was edited for posterity, the less it was read by contemporaries,

and to his constant chagrin few of its recipients attached the slightest importance to it, and, excepting for the loan copies, nobody kept a complete file. But the photographs were expensive, and the issue remained at twenty copies.

Ultimately, Bell intended a complete set to go to the Library of Dalhousie College at Halifax, and another to the Public Library at Baddeck, but the only library copies ever distributed were those sent during his lifetime to the Volta Bureau and to the Smithsonian Institution. The inviolability of the Smithsonian was a passionate belief with Bell; there he deposited his famous 'sealed packages,' and there, come what might, he felt his 'permanent record' would be accessible to posterity forever.

CHAPTER XXVI

(1)

In 1910, Graham Bell went on a year's journey around the world. With him went Mrs. Bell, his young associate 'Casey' Baldwin, and Baldwin's beautiful young wife.

Bell never took holidays in the conventional sense of abandoning all work and taking six weeks off for rest and change. For any extended absence he took his work along. (Undoubtedly, this was because he wanted to work, but, nevertheless, a notebook full of data was a very present alibi when he was bored.) Perhaps his interests were so varied that he did not need rest and change. At most he went off to his houseboat on Beinn Bhreagh, with the *All-Story Weekly* and a novel, and warmed up tinned food for himself over the week-end; or went to Atlantic City for a few days in the spring and had himself wheeled up and down the Boardwalk. For diversion he read detective and mystery stories, and went to moving pictures.

Bell was naturally responsive to beauty, but he made no pretence of critical appreciation of the arts. He had no interest in literature as such. When he read a novel he wanted a good plot and plenty of action.

When Mr. Charles Freer offered his valuable art treasures to the Smithsonian Institution in 1904, Bell was named as one of a committee of four officials to visit Mr. Freer in Chicago and inspect the collection. He took his daughter Marian along.

The other members of the committee were mature gentlemen of scientific tastes, with very much Bell's point of view on what, for want of a better word, may be called art. Politely and gloomily the four surveyed the nine hundred and fifty pieces of pottery from the Far East and Central Asia, the priceless group of ancient Chinese and Japanese bronzes, and the ceramics so rare that they were still unidentified. Not even the one hundred framed paintings of James McNeill Whistler and the entire decorations of the Peacock Room could move them to any enthusiasm for this dingy array, valued at more than a half-million dollars. They looked to Bell like 'a lot of old pots,' and his distinguished confrères thought so, too. And it was Marian Bell's insistence, Bell always said — with delighted chuckles — that saved the Freer collection for the Nation.

(2)

On the voyage between Australia and New Zealand, on this journey, Bell watched the soaring flight of albatrosses following the ship, studying their steady progress against a head wind, their long, narrow wings motionless, their heavy heads and short tails disproving everything that man knew about heavier-than-air flight. All the way across the Pacific he worked on a scheme of composite photography, making four-, six-, and eight-hour exposures of blueprints from graphical diagrams of his sheep studies. All the way around the world, he punctiliously called on American consuls, visited institutions for the deaf, and collected Government publications everywhere from which he as-

siduously studied educational methods, infant mortality, natural resources, rainfall. His wife has given a typical picture of him in Queensland, Australia, sitting in a canvas chair on a wide verandah, his back to the sun, 'studying up information.' Strong sunlight hurt his eyes, and he habitually slept with a towel wrapped around his head to protect them from morning glare. Even in the heat of India he clung to an enormous bathtowel for the purpose.

Everywhere he made notes about oddities. The sex of strawberries, the stinging tree, the lawyer vine. He went along with the rest of the party to photograph ant villages. He noted with gusto that by sprinting he had succeeded in surprising 'stark naked' a family group of Australian black-fellows, which was fully clad when the slower-moving, younger members of the party came on the scene.

Everywhere Bell was received with semi-official honours. Colonial Governors gave dinners for the party, and, in Australia, where Bell was asked to testify in a Government enquiry on Melbourne's telephone service, there were official receptions and lavish bouquets for Mrs. Bell and Kathleen Baldwin.

'The personality of Dr. Graham Bell is striking,' a Sydney newspaper commented. 'Tall and broadly built, he resembles in the characteristics of feature, hair and beard, the well-known portraits of Charles Gounod, the French composer. To mark the leonine activity and physical proportions of the great inventor, few would guess he was "poitrinaire" (as the French say) — weak-chested, and at-

tacked with incipient consumption from which two brothers died.'

He talked to the reporter with great fluency and enthusiasm about the low death rate, the climate, the natural resources.

In India, the party sent off letters in the first air post, a feature of the fair at Allahabad, in which a rather battered flying machine hopped bravely across the Ganges, carrying a mail bag to the opposite bank.

(3)

At Monte Carlo, Bell and Baldwin watched flat-bottomed hydroplane boats roaring across the blue bay, smothered in clouds of foam, and, at Milan, they met the Italian engineer Enrico Forlanini, whose submerged hydrosurfaces were giving him higher speeds with less commotion.

Forlanini was interested to hear of their work with the Query, and invited them to come to Lake Maggiore to see his boat. And Bell, who never rode in any of the contraptions of his own laboratories, was too polite to decline when Forlanini offered to take the craft out for their benefit. For all his interest in the principle of submerged hydrosurfaces, Bell had very little enthusiasm for personal adventuring at forty-six miles an hour. But he went.

(4)

In Paris, Bell decided to buy a seventy-horse-power Gnome motor — one of the best light motors then made — to try to fly the Cygnet II. If Bell ever suspected any inefficiency in his kite structures,

he never admitted it, and he always spoke of the Cygnet as a successful flying machine which had been under-engined.

The Gnome Company declined to sell a motor unless one of their own mechanics was retained to install it, and, as this involved rather more outlay than Bell wanted to make, Baldwin went into the Gnome plant for six weeks as an apprentice mechanic to qualify for the part. One of his shopmates there was the young Peruvian, George Chavez, who was getting ready to make his famous flight over the Alps.

CHAPTER XXVII

(1)

The Gnome engine did not get the Cygnet into the air, but its seventy horse-power and its air propeller did wonders for the Query's successors. Bell and Baldwin realized that the use of an air propeller was a distinct advance over Forlanini's water-drive, and they now began to work seriously on submerged hydrofoils and to apply the principle to high-speed boats. Without abandoning their first intention of getting a flying machine off the water, Baldwin saw the great possibilities of the submerged blades for carrying loads on the water at high speeds. The specific gravity of salt water is about eight hundred times that of air. This meant that the area of the submerged hydrofoils need be only one eight hundreth of the wing area of an aeroplane. On these relatively small blades the craft could carry enormously greater loads than an aeroplane at high speeds because it got its support from a medium roughly eight hundred times as dense as air.

(2)

As always, without enquiry as to existing knowledge on the subject, Bell began at the beginning to find everything out for himself. It was wasteful and slow, but he liked to work that way, and he had plenty of time and plenty of means. As each new form or adjustment was suggested, a new model was made and tried. Little frames of tin and of wood

were put together, the hydrofoils or blades were set at one angle or another, and each arrangement was towed behind a motor boat on the quiet waters of the little harbour of Beinn Bhreagh, a spring balance fastened on the towline to register the pull.

It was the method of trial and error that Bell had used with the kites and with his propeller models, but now there were accurate calculations of lift and pull, and, in the end, Baldwin's practical application of these measurements to a working speed-boat design.

The hydrofoils were ultimately developed, from wooden flanges of various sizes and shapes, to a ladder-like arrangement of steel knife-blades attached to the bottom of the hull. As the craft advanced, the hull lifted clear of the water into the air, while the bottom blades of the ladder remained submerged. The craft thus got rid of the water resistance of the hull, which ordinarily impedes all boats, but continued to get water support from the submerged blades.

This joint work on submerged hydroplanes comprises the fullest, although by no means the first investigation that has ever been made on the subject, and it resulted, in 1919, in the fastest boat in the world. The craft were called 'hydrodromes' in accord with Bell's stand on 'aerodrome,' and the term was abbreviated to 'H.D.' Once, when there was a period of long and exasperating delay in the work, the current H.D. was known as 'Hope Deferred.'

To the uninitiate, the H.D.s always looked like boats that were trying to fly and couldn't. They got

upon their toes and went skittering across the Bras d'Or like giant water-spiders, over the water and yet in it, free of its great resistance but using its support.

The third of the series, with the old Gnome engine and a second and smaller motor, travelled at a little over fifty miles an hour, and one sunny afternoon in 1913, when the visiting Prince of Monaco's steam yacht swung at anchor in the Bay, Baldwin took the H.D.–3 out to offer the hospitable spectacle of her speed, and concluded a dizzy circumnavigation of the Bay, and His Highness's distraction, in the inadvertent sensation of his first smash.

(3)

Genius as he was, Graham Bell was wholly incapable of applying any one of his own conceptions to a practical end. To Bell, the search for knowledge was the only really absorbing thing in the world. Goals were never as important to him as his progress toward them. His wife, always his closest companion, lamented that 'he never wanted to finish anything,' and that 'he would be tinkering with the telephone yet if I hadn't taken it away from him.'

It was Bell's great good fortune to attract to himself men like Watson and Tainter, to whose loyal coöperation he owed the practical completion of the telephone and the photophone; the associates of the Volta Laboratory, and of the Aerial Experiment Association, whose joint work he inspired and shared.

But none of this was true collaboration. Bell was

too much the individualist to work for very long with another mind as good as his own.

Watson and Tainter were skilled mechanics who began as his assistants, working under rather than with him, and while Bell shared in the work of the Volta Laboratory and the A.E.A., he did not merge himself wholly with either activity. With part of his mind he always 'walked in the wet woods waving his wild tail.'

While the young men of the A.E.A. built and flew biplanes, Bell clung to his belief in tetrahedral structures, and now that Baldwin's hydrodrome was making fifty miles an hour, Bell began to talk of making his own application of hydrosurfaces to sailing boats, of building a houseboat with sails, of propulsion by flapping wing devices — of any number of things which were entirely his own.

Nevertheless, in this work with Baldwin, for the first time in his long life, Bell had years of constant working touch with a really able mind, and it was his first approach to true collaboration. Disliking competition as he did, the association was possible, and congenial, only because of the difference in their ages, and the affectionate personal relation which led Bell to speak of the younger man as his 'son,' and led Baldwin to loyal efforts to make hydrosurfaces work on sailboats, where they wouldn't work, instead of urging his own design, where they would.

'I think I have said nothing of Mr. and Mrs. Baldwin,' Mrs. Bell's cousin, Mary E. Blatchford, wrote from Beinn Bhreagh in 1911. 'Popularly they are called *Casey* and *Kathleen*, in spite of *his* name

being Frederick! I believe hers is really Kathleen. Mabel calls them her adopted children, and if she had not already adopted them, I should . . . each one is nicer than the other . . . Casey is working with Mr. Bell, and also making experiments on his own account. He wants to construct a boat that can fly from the water. Mr. Bell's present experiments are on the resistance of wheels of different sizes and shapes to water. Not understanding the matter through and through, I may have stated it quite wrong; but you may be sure Mr. Bell knows what he is about even if I don't.'

CHAPTER XXVIII

(1)

In 1914 Canada went to war.

Baldwin, who was a keen yachtsman, and had once — when a youngster — shipped across the Atlantic before the mast and been signed off at Liverpool as 'able seaman,' applied for active service overseas in the Canadian Naval Reserve.

Bell was nearing seventy. In eight years he had come to depend on his younger associate to a degree only too plain, and too disquieting, now that Baldwin was going off to the wars. When the Naval Board notified Baldwin that a mate's papers were required for overseas service, and that without them he could only be accepted for coastal patrol duty at home, Bell countered with the proposal that, instead, he should develop the H.D. type into a fast patrol boat for war purposes. Her inch or two of submerged hydrofoils would render her safe in mined areas, and her air propellers convey no water vibration to be picked up by enemy hydrophones. She could not be sighted by submarines as easily as aircraft could. The type would be fast and seaworthy. It had obvious advantages for sea scouting. He prevailed upon Baldwin to devote himself to the design of a fourth H.D., instead of enlisting to repulse an enemy invasion very unlikely to materialize, and so the H.D.–4 began.

But Baldwin's efforts to present his submarine chaser to the British Admiralty met with no more

success than Bell's attempt to dispose of the telephone to the English Post Office. And Bell felt his own position complicated by President Wilson's proclamation of American neutrality, 'in word, thought and deed.' He took it with immense seriousness. The Beinn Bhreagh Laboratories were converted into a boat-building plant, as a war effort of unassailable neutrality, and it was not until the United States joined the Allies in 1917 that the promise of two Liberty motors from the United States Navy Department revived the long-deferred hope of the H.D.–4.

Governments move slowly. In 1918, two Renault motors reached Beinn Bhreagh, and although they developed only two thirds of the power for which the craft was designed, Baldwin installed them with good grace and made upwards of fifty-three miles an hour. A year later the two promised Liberty motors turned up and the H.D.–4 developed her brilliant record speed of 70.86 miles an hour, which made her the fastest boat in the world.

She looked like a big grey cigar.

The sixty-foot torpedo-like hull had outrigger floats that projected like fins, one on each side at the bow. These carried the engines, and, underneath them, slung on a steel tube that passed through the hull, were the two main sets of hydrosurfaces — ladder-like sets of steel blades cambered like aero surfaces, and set at a slight dihedral angle. This apparently trifling angle is a basic feature of the design. It makes the lower end of one blade about on a level with the upper end of the blade below it, so that instead of leaving the water at one jump the blades

rise continuously and smoothly. In the Laboratory parlance this is known as automatic reefing. The slight angle also adds greatly to the stability.

On these two main sets, and a set at the stern which also acted as a rudder, the hull rose clear of the water at twenty miles an hour. At sixty miles the big craft, weighing close to five and a half tons, ran smoothly on about four square feet of submerged steel blades. The three-point support, as in an ice-boat, prevented the twisting effect always present in a structure supported at four points.

The best description of the H.D.-4 in action was written that year by the late W. W. Nutting, whose able article in his magazine *Motor Boat* formed the basis of a Smithsonian Report on the machine.

Now hop into the cockpit [he said] and we'll take a ride, and if you want to hear anything for the rest of the day, stuff some cotton into your ears before the motors are started, for they aren't muffled. Over goes the starboard motor with the crackle of a machine gun and those on the dock scurry from the cyclone caused by the whirring propeller. The mooring lines are cast off and we slip out into the lake at about ten knots.

Baldwin gives the air to the port motor and the exhaust becomes a continuous roar. At fifteen knots you feel the machine rising bodily out of the water, and once up and clear of the drag she drives ahead with an acceleration that makes you grip your seat to keep from being left behind. The wind on your face is like the pressure of a giant hand and an occasional dash of fine spray stings like birdshot. . . . Baddeck, a mile away, comes at you with the speed of a railway train, and you brace yourself for the turn as Baldwin drives her through the narrow passage inside the island. You feel that she's going to skid as he starts to make the turn at full speed, but she doesn't. Just as the struts of the rudder set are sufficient to steer

her, so are those of the main planes sufficient to keep her from side-slipping. Even more startling is the fact that she doesn't seem to heel a degree as she makes the turn. It's unbelievable — it defies the laws of physics, but it's true.

(2)

Baddeck was full of newspaper men and news-reel photographers that summer of 1919, waiting for the roar of the H.D.–4's engines, and visiting schoolboys hung about the Laboratory wharf, their eyes bulging with desire, hoping that some acute but not fatal seizure would incapacitate one or both of the crew and that a substitute would be taken aboard.

The news-reel men importuned Bell to climb into the cockpit, and — a little unwillingly, because he had never ridden in her, and never intended to, and he didn't think it entirely honest — he consented. But he made Bobby, Baldwin's young son, get into the picture too.

The newspapers, very naturally, featured the craft as Bell's design, until at last he wrote to Nutting to remind him that the H.D.–4 was Baldwin's invention, and to caution him to make this clear in his article. 'Honour,' he said, 'to whom honour is due.'

CHAPTER XXIX

(I)

In these last years Bell's zest and energy were little abated, but his work was done.

He still declined to write his reminiscences, and insisted that he was more interested in the future than in the past. Nevertheless, he painstakingly gathered up the records of the past, and got them ready for preservation in the *Beinn Bhreagh Recorder* — ancestral portraits; births, marriages, and deaths of Fifeshire Bells and Colvills. From its earlier place as a supernumerary, the *Recorder* had moved down stage in a major rôle.

The old kite house on the hillside at Beinn Bhreagh became a 'museum.' The smaller of the old kites and models of big ones were suspended from the roof. Giant glass-enclosed cases held pieces of old apparatus, old models — all signed and dated, most of them in Bell's own neat, tight hand.

At one end of the long building, Bell used a partitioned space as an office. It was hung with framed blueprints of drawings for the giant kites and the A.E.A. machines. It was unpainted, with a bare wooden floor, and the plainest of furnishings. In an old Morris chair, a rug over his knees, Bell worked at a little, rough, cherry-stained wooden table. On it a sawed-off wooden pyramid, full of birdshot, held a lead pencil, blue and red checking pencils, and a pen, in exact and unalterable order.

A piece of wire for a pipe-cleaner was stuck down the middle. He smoked incessantly. Two pipes were kept filled, one to smoke and a cool one to alternate. His ash tray was an old tin tobacco box, fitted crossways with two metal bars on which he rapped out his pipe. When it was suggested to him that he smoked too much, he replied, with mock seriousness, that he had had an example of excessive smoking in his own father, who had smoked even more than he, and had been cut off at the untimely age of eighty-six!

There was a shabby old sofa in the corner, on which Bell often reclined to work, and on which he sometimes took his famous naps from which he never could be roused. When shaken and called, he snored and slept the sounder. It was a perfect defence.

His late hours were a lifelong habit. Usually he breakfasted at ten. From eleven to twelve he dictated his longhand 'Home Notes,' which had developed into a running chronicle of the family activities as well as his own. For this morning dictation he wore a heavy bathrobe and, even in the hottest weather, wrapped himself up in a rug. He insisted that the rug kept out the heat as it kept out the cold. Then he had a glass of buttermilk, dressed and drove to his office — to the Museum at Beinn Bhreagh, to his father's old Georgetown house in Washington — where he worked till half-past five or six. The New York *Times* began his working day. At Beinn Bhreagh the funny column in the Sydney *Post* was his favourite reading, but the New York *Times* — for its full text of speeches

and its complete world news — was indispensable wherever he was. During the war he had all of Wilson's and Lloyd George's speeches read aloud to him. He admired both warmly, and he wanted their words declaimed — with suitable dramatic pauses, permitting him to shout 'Hear, Hear,' 'Yaw, Yaw,' and 'Applause!' at intervals, rapping out his pipe for emphasis. He was fond of shouting great 'Ah ha's,' when spotting an error, or pleased for another reason. He made a prodigious whistle by blowing through his closed palms, and used it to answer his coachman who was equipped with a whistle to announce himself at Beinn Bhreagh.

Bell wanted the Laboratory staff and the house servants to walk in without 'disturbing' him by knocking at his office or study door. If he was busy, he paid no attention to the visitor. And, if there were many interruptions, a giant NO was printed on a sheet of paper and pinned on his door, and then only his secretary dared penetrate.

Since the episode of the Elisha Gray letters, Bell never threw anything away. His files were choked with valueless things — circular letters, telegrams, invitations, greeting cards, the scribbled drawings of his grandchildren (marked with their names and the date). Once some correspondent forwarded a letter for his information, saying that it had no special value and might be destroyed when read. Bell had it returned with the message that it was against his principles to destroy papers and would the writer please dispose of it himself.

He would not sign any letter that did not have its 'yours sincerely' closed up to the last written line.

Otherwise, he said, something could be written in to change the meaning. He was fond of telling of the plight of a certain Congressman who found himself with a suit for breach of promise on his hands. He had with difficulty proved that he had autographed a blank sheet of paper, on which the unscrupulous lady had forged a tender message. He never signed blank cards for autographs, but sent out a form letter with his signature attached, in response to the hundreds of requests that reached him. Shorthand was never used for any notes, because something might befall the user and the notes never be transcribed. He was increasingly particular about the sequence of dates, the initialling of all entries in his notebooks. Twenty years of litigation had left their mark.

(2)

Bell never had any real recreations, and he had gradually abandoned even his walks at Beinn Bhreagh. He took his canoe out for a midnight paddle only now and then. Work was his sole preoccupation, and as new interests became fewer, old interests were spasmodically revived. The selenium and lampblack experiments of the eighties came back briefly. An assistant was engaged to prepare diagrams for a graphical index of Fay's 'Marriages of the Deaf,' long planned. An old study of the Hyde genealogy was completed and published, with Bell's conclusions concerning the relationship between longevity and fertility. People who lived to great age had more children, he found, than persons who died in middle life. This led to a

year or two of interest in longevity and a collection of material concerning long-lived persons.

He made long dictations on his theory of education, 'auto-education,' he called it, which provided that children should find everything out for themselves. He recommended parents to encourage 'a strong spirit of egoism tempered by altruism' in their offspring. 'I think it certainly should be one of our objects in the formation of character to preserve and develop a strong personality [he wrote], a strong individuality that will not readily give up his own ideas and be swayed by others.' He spent a summer working out simple experiments to demonstrate the idea of 'auto-education,' and another summer in elaborate experiments in condensing water from the breath, and condensing fresh water from the sea.

Occasionally he made public addresses; on Eugenics, urging 'desirable' persons to marry 'desirable' partners; on Aviation, urging the establishment of an air mail to develop peace-time flying. When, in 1918, the first air mail was sent from Washington to New York, Bell, in Washington, sat up all night drafting a letter to be sent to the Aero Club of America. He had an engagement in Philadelphia the next evening, where he was to be one of ex-President Taft's guests at his dinner for 'The League to Enforce Peace,' and, fearing to oversleep and miss his train, he didn't go to bed at all. The train for Philadelphia was crowded, and he had four thoroughly uncomfortable hours in the smoker. When he arrived, shortly before six, he was, he said, 'never so glad in my life to get a stretch at the hotel before dressing for dinner.' The dinner was at

eight. Bell woke at a quarter-past ten. 'I was so ashamed of myself,' he said, 'that I didn't even show up at the Convention [of the League] next day.' He went to a moving picture instead, and later took a train for New York and wired his apologies to Mr. Taft from there.

From time to time he sat on platforms to receive gold medals and hear eulogies of his services to mankind, and to ponder — 'Why do they offer this to me now — what good is it to me now? It would have meant everything to me when I was a young man.'

He travelled out to Chicago to open a day school named in his honour, with class-rooms for deaf children, doubtless remembering the day when he had lost his motion because he had kept the meeting past its lunch hour. All the little deaf pupils filed by to shake hands, looking up at the great man with awed smiles.

(3)

There was an absurd story, current in these later years, that Bell refused to have a telephone near him. On the contrary, his Washington house and his Beinn Bhreagh estate were very fully equipped with telephones. He even had one at his sacred retreat, the houseboat *Mabel of Beinn Bhreagh*, connected by a direct line with his house. Except in cases of real emergency, no one but Mrs. Bell was permitted to use this. Some one listened for her and repeated his answers. Nevertheless, Bell, who had all the punctilio of his generation, deplored the casual manners his invention had introduced. Nobody, he

said, would dream of coming to one's house and demanding an audience while one dined, or bathed, or slept; but every one made these peremptory interruptions by telephone. He always made indignant protest when any member of his family left the table to answer a telephone call.

(4)

In 1915, Bell talked from New York to Thomas A. Watson in San Francisco, to open the coast-to-coast telephone service.

In anticipation of this event, it was suggested to Bell that a conversation should be prearranged.

Perhaps there was some fear that Bell's hearing was not all it had been; perhaps it was a precaution against some unforeseen hitch in the programme. It was not an unreasonable suggestion, everything considered, but the light of old battles gleamed in Bell's far-from-senile eye.

He flung the draft of the suggested conversation from him. If he didn't hear Watson, he'd say so! And no one knew what he was going to say, until the great moment came, and he lifted the receiver in New York and spoke — 'Hoy, Hoy, Mr. Watson! Are you there? Do you hear me?'

And, happily, Watson heard. Thirty-four hundred miles away, out on the Pacific edge of the continent, he answered that he was indeed there and that he heard Bell perfectly.

The event was, as Bell said, a triumph for Theodore N. Vail, for John J. Carty and their engineers, for the 'many, many minds' that had built up modern telephony out of his invention. But his own

triumph came when a duplicate of his Centennial telephone was connected — that instrument of 'boiler-plate' iron which was, in his estimation, the most efficient telephone ever constructed. (The modern telephone receiver is Bell's first instrument, then used for both transmitter and receiver. Once in later years, when his office telephone was out of order, at Beinn Bhreagh, he declined to have it repaired when he discovered that only the transmitter was faulty. For months his secretary first shrieked into the receiver and then clapped it swiftly to her ear. And it was a perfectly good telephone, if a little inconvenient.) Into this old instrument Bell was asked to repeat his old summons, 'Watson, come here, I want you.' And Watson, who had rushed down the little attic passage forty years before, to find his employer wiping sulphuric acid off his trousers with his handkerchief, replied that it would take a week to get to Bell now. A little later, Boston erected a tablet perpetuating the memory of that historic exchange at Exeter Place, and Graham Bell and Mabel Hubbard Bell were both there for the unveiling.

A year later, they were guests of honour in Brantford when the Canadian city unveiled the elaborate memorial erected there to commemorate the invention of the telephone within its radius, and when the old Bell homestead on Tutelo Heights was dedicated as a public park.

'There are some things worth living for,' Bell said, 'and this is one of them. I came to Brantford in 1870 to die, having been given six months to live.' He was glad, he said, that he had survived to

witness the unveiling of this memorial. He recalled Brantford of the old days, the Grand River and his 'dream place' under the birch trees at Tutelo Heights . . . he could not claim to be the inventor of the modern telephone — that was the product of many minds — but he had initiated the transmission of speech, and he had initiated it here. Brantford had been unnecessarily perturbed about the Boston tablet — he set their minds at rest.

Afterward he stood on the marble approach to Walter Allward's heroic bronze figures of Humanity, with the symbolic figures of Knowledge, Joy, and Sorrow, bridging space; and took off his hat and posed for the news photographers. Forty years before he had been a daft youth, stringing stovepipe wire along the fences. Brantford had apologized handsomely.

(5)

A warm admirer of President Wilson, Bell stood out against his family in his stout assertion that history would vindicate Wilson and recognize him as the greatest President of the United States since Lincoln. Bell contended that he was one of the few persons in the country who had read the text of the Covenant of the League of Nations, and, having read it, insisted that Wilson was being criticized and abused on prejudice and not on facts. Bell undoubtedly felt a strong kinship for Wilson in his aloofness from intimates, his uncompromising honesty and his fixed beliefs. Perhaps the widespread criticism of the President — much of it malicious — stirred old memories for Alexander Graham Bell.

At its height he sent Wilson a telegram of encouragement.

Although Bell's aloofness was not Wilson's 'desert loneliness among a different race of men,' people were not really necessary to him. The world was so full of a number of things — objective things, to investigate and test, and make dictations about; conservation of heat from the sun's rays; harnessing the power of the tides; why does a cream pitcher have a projecting lip? But though he was not a mixer, his tremendous vitality, and versatility, made him a famous host. His Wednesday Evenings were to become as renowned in Washington as Mr. Longfellow's had once been in Cambridge. The coveted invitations brought interesting men together, scientists, explorers, heads of Government bureaus, educators, an ambassador now and then — and Bell's cordiality and sheer personal magnetism drew interesting talk from shy explorers and research chemists who would have been otherwise mute.

(6)

In the summer of 1920, both the British Admiralty and the United States Navy Department sent commissions to inspect and report on the H.D.-4. On July mornings the big grey craft rushed down her mile course on speed tests, streaking the smooth bay with her white wake, startling the sea-gulls into wheeling flight. To demonstrate her usefulness as a submarine chaser, she carried upwards of three thousand pounds of extra load in dummy torpedoes, one on each side, dropping them off one at a time to show that she could do

it without disturbing her balance. The American officers listened with hydrophones, and could not pick up a sound. Both commissions were impressed, and in recommending that the type be built for further experiments the United States Board observed that 'at high speed, in rough water, the boat is superior to any type of high-speed motor boat or sea sled known.'

(7)

Early in the month the forty-five-foot ketch-rigged yawl *Typhoon* was launched at the Beinn Bhreagh boat-building plant, and W. W. ('Bill') Nutting, 'Casey' Baldwin, and Jim Dorsett, raced her across the Atlantic, in their famous record run to Cowes, fifteen days from land to land. Everybody at Beinn Bhreagh, including the officers of the British Admiralty Commission, worked with a will to get *Typhoon* off on time. Graham Bell felt easier in his mind when they had stowed away in the galley the two tea-kettles which he had devised into an apparatus for condensing fresh water from the sea.

(8)

That autumn Graham Bell went back to Scotland to pay his last visit to his native Edinburgh.

He found Mr. John Macleod, the son of his old genealogist, and with him unearthed new facts about the Bells of St. Andrews. He spent afternoons in the city library searching old directories for the addresses of his father and mother, his grandfather, and his grandfather's brother James. Ultimately, in triumph, he rescued James and his occupation from

the obscurity into which that honest brewer had been allowed to fade. Day after day, patient library assistants climbed to dim recesses for more dusty files.

He took his granddaughter to see the house where he was born, on Charlotte Street, and red-cheeked children — ringing doorbells up and down the block — paused to stare at the tall old gentleman in the fur-lined overcoat.

'I remember that window,' he said; 'it looks just the same.'

On the way back to his hotel, reliving his boyhood, he was lured by a window full of the mutton pies which had tempted his young palate. He was on a diet and they were forbidden to him, but he recklessly ate one in the shop and carried two back to the hotel in a paper bag as a treat for the younger members of the party. The recipients thanked him politely, shuddered, and set them on the mantel; all of which Bell divined and perhaps intended. He returned at midnight, after his wife was asleep, learned that the leaden dainties were still intact, and gleefully bore them away.

Edinburgh looked just the same, he said, excepting that the houses seemed smaller. But many of the friends of 1906 were dead, and he felt very much alone. He motored out to the Corstorphine Hill, but he had forgotten that it was so far, and that he would have to get out and walk to Rest-and-be-thankful. He was too old to climb. 'Ah, well,' he sighed, 'never mind. Let us go back.'

He went north to Elgin, and to Pluscardyn Abbey, and to Covesea to find the fisherman's cottage where

he and Mabel Bell had stayed on their honeymoon. At Covesea two or three deserted and dilapidated buildings huddled on the grey coast. They could not be sure which one it had been. The wind blew in from the North Sea, bringing rain, and they stood hand-in-hand in the bleak drizzle and smiled wearily at each other — 'Do you remember?' 'Yes, I remember — the day you went off to buy me the fruit . . .'

Even Pluscardyn was changed. Bell had been sure that this, at least, would be the same. As a general principle he did not endorse the sentiment that clung to ruins for their own sake, and declined to contribute to the upkeep of mouldering walls that had outlived their usefulness, no matter what their history. But Pluscardyn was more than a ruin; it was the dearest memory of his boyhood at Elgin. He drove over the miles that he had once taken in his brisk stride, and recited his youthful lines to 'Pluscardyn, Pluscardyn, ivied and grey.'

The peaceful old abbey had been 'restored' to new usefulness in parish activities. The ivy had been torn away to permit a wooden superstructure to rise hideously level with the moss-grown tower. The grass plot on which Bell had lain at seventeen was replaced by a cement floor, and the Elgin chauffeur, pleased with its excellence and solidity for parish dances, was distressed and nonplussed to see the disappointment of the old gentleman who kept on saying, '*This is not Pluscardyn.*'

One of the Elgin young ladies whose three-part songs Bell had accompanied, remembering him romantically after fifty years, called upon the party

in the evening after the return from the abbey. Bell did not see her. He could bear no more memories, and had gone early to bed.

Back in Edinburgh, a reporter found him in a depressed mood, rare for him, and got an interview in which Bell admitted that he felt a stranger in his native land, and that his advice to persons intending to revisit the scenes of their youth was 'Don't.'

Happily the visit was not to end on this note. As he was leaving Scotland, Bell learned that he was to be offered the freedom of Edinburgh. The formal invitation reached him in London a day or two later. He drove to Cook's to cancel his sailing himself. Then, his spirits restored, he climbed into a taxi and asked the driver to recommend a moving picture. It was Mabel Bell's birthday, and the anniversary of their engagement. He noted the coincidence of all three dates in his notebook.

So he travelled back to Edinburgh once more, having so lately bidden it farewell forever, and saw the Castle Rock loom up again in the November dawn. The Royal High School joined in the city's welcome, and, as a famous Old Boy, he was privileged to give the boys a half-holiday and to hear their lusty and appreciative yells in his honour.

That afternoon Mabel Bell drove with him to the City Chambers to see him made a Burgess and a Guild Brother of the old grey town to which his grandfather had come to establish the family fame a hundred years before, where his father and mother had met, and married, and where he was born. She sat, holding a great bouquet of carnations tied with black and white, the City's colours, while the

seventy-two councillors stood in their scarlet robes, and saw the Lord Provost hand the traditional silver casket to 'Alexander Graham Bell, Esquire, Doctor of Philosophy, Doctor of Laws, Doctor of Science, Doctor of Medicine.'

'I have hardly words,' Bell said, 'to express how deeply I appreciate the honour that has been conferred on me to-day. I have received many honours in the course of my life, but none that has so touched my heart as this gift of the freedom of my native city, Edinburgh . . . I can assure you that I shall always look back upon this scene as the most memorable event in my life.'

Mabel Bell smiled at him as they drove away. 'Alec dear, this would be a great day for Alexander Bell.'

He would not permit the City's silver container to be packed. He carried it himself whenever it had to be moved during the return journey to America. Landing at St. John, the Customs Inspector asked, 'What have you there, sir?' And Bell said, 'The freedom of my native city, sir.'

CHAPTER XXX

(1)

Bell always insisted on prompt and expert medical attention for any member of his family, but he was a bad patient himself. He didn't want doctors taking liberties with him; he resented their medicines, and their diets, and their orders to take exercise.

For years he had been on a diet to combat a diabetic tendency, a regimen which he obeyed at his wife's pleading, but with very bad grace. In Washington, in these last years, he frequently slipped away from his office to eat ham-and-eggs in a cheap Georgetown lunch-room; or, from his New York hotel, to order fish cakes at Child's. He liked food, and he had been an enormous eater in the days when Mark Sullivan remarked his bigness in every dimension. With 1921 he showed definite signs of failing strength.

That winter of 1921–22 was spent in the West Indies, and in Florida. He continued to work, to call on consulates and to study Government publications everywhere he went, but when his ship touched at Venezuela, and the Caracas School for the Deaf invited him to pay it a visit, he was — for the first time — too weary to accept. Nevertheless, his enthusiasms continued, if they were fewer, and in Jamaica he went off alone to Black River, motoring the greater part of a hot day, in an unsuccessful search for the grave of his young relative, Melville

Richard, master of the *Jane of Glasgow*, who had died in that port more than a century before.

But Bell was very tired, and he hated hot weather and the white glare of coral roads in the sun. He wanted to get back to Cape Breton. In Washington that spring, a diagnosis revealed nothing alarming in his condition. It may be that he would not permit a full examination. At Beinn Bhreagh he got to work again with much of his old vigour, restored by its keen air, the June freshness and the cool nights.

Baldwin had designed a hybrid structure using Bell's tetrahedral framework, with hydrosurfaces, in a naval towing target. Existing naval targets could be towed only at a speed of eight knots, and from full-size tests of the new design they knew that it could be towed by a destroyer at twenty knots. Its further advantage was that its cellular structure permitted it to be taken apart and shipped in small compass, or expanded to any size by the addition of more tetrahedral cells. It was light, rigid, mobile.

The tetrahedral principle was very near and dear to Bell. He wanted to see a towing test of the target. And he wanted to complete Volume 25 of the *Beinn Bhreagh Recorder*, and to begin the next volume. Days were spent in planning new biographical data to be preserved in it, and in the arrangement of photographs of himself at all ages, previously selected for a new volume. A collection of photographs of his wife was to follow these. He wanted to make new plans for the continuation of the Laboratories, and he watched the calendar with

impatience for the arrival of his cousin, Charles Bell, who was also his brother-in-law, and with whom he had arranged a visit to Beinn Bhreagh to talk over all these matters.

Undoubtedly Bell knew that he had a very short time to live, yet he was sure that his fierce spirit could sustain him until he should have completed all his plans — for the Laboratories — for the *Recorder*. And no one in his household could believe that the end was measurably near. He rested rather more frequently than usual, he drove to his office only occasionally, sometimes he went to bed for whole afternoons, but he had often done that when he was bored. One of the few physicians whom Bell liked, and ever obeyed, Dr. Roy, recognized his weakened state as pernicious anæmia, and specialists were summoned from the United States. But they did not have time to arrive.

At the end, Bell's indomitable will fought his growing weakness, to make his last dictation. When he spoke, with strain and difficulty, he was reassured, with 'Don't hurry.' 'I have to,' he said. That night he died. It was August 2, 1922. He was buried on the hilltop at Beinn Bhreagh, underneath his tetrahedral tower.

Nothing could have been more fitting for his free, agnostic spirit than the simple service planned by Mabel Bell. He was buried in one of the old homespun working suits that he always wore at Beinn Bhreagh, with the little red button of the Legion of Honour in his buttonhole. And his coffin of pine boards, made in the Laboratory workshop, was carried at the last by his workmen. Old Hector P.

MacNeil, who had lost his eyesight in Bell's service, was the only honorary pall-bearer.

There was no conventional mourning.

The smaller grandchildren played about the lawns that day as usual. At the grave all the women of the family wore white, and the men their usual summer tweeds and flannels. All day, from far and near, hundreds of people had climbed the hill to pay him their last respect.

There was no formal ritual.

The Reverend John Mackinnon, of Baddeck's Presbyterian Church, recited the Lord's Prayer. A young Cape Breton singer, whose voice always gave Bell pleasure, led a hymn or two, and sang a verse of Stevenson's Requiem. It was a day of mist and cloud. As the earth closed him in, under the grey skies he loved, Jean Macdonald's voice filled the little clearing —

> 'Here he lies, where he longed to be . . .'

THE END

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